FISCAL YEAR 1983 DEPARTMENT OF ENERGY BUDGET REVIEW

(Nuclear Fission R. & D. Small-Scale Hydro, Electric Energy Systems & Energy Storage Systems)

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND PRODUCTION

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

NINETY-SEVENTH CONGRESS

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*On assignment to Budget Committee for 97th Congress.

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FISCAL YEAR 1983 DEPARTMENT OF ENERGY BUDGET REVIEW

TUESDAY, MARCH 9, 1982

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met, pursuant to notice, at 2 p.m., in room 2318, Rayburn House Office Building, Hon. Marilyn L. Bouquard (chairman) presiding.

Present: Representatives Volkmer, Wolpe, Lowery, and Hollenbeck.

Staff present: Mr. Lee Wallace, minority energy director, and Mr. Nelson Milder, staff consultant.

Mrs. Bouquard. We will come to order.

Before we hear from our witnesses, I would like to ask unanimous consent that pursuant to House rules television recording of today's hearings be permitted.

No objection, so ordered.

I do want to welcome the Assistant Secretary for Nuclear Energy, Dr. Shelby Brewer, and two of his Deputy Assistant Secretaries for Nuclear Fission Programs, particularly Gordon Chipman, who handles reactor programs and served so well on our subcommittee staff.

We are very happy to have you with us today, Gordon and Frank.

Prior to the DOE testimony we hope to be hearing from the Honorable Sid Morrison of Washington on the breeder technology program. It is always a pleasure to have a Member testify, especially one who is so knowledgeable on nuclear fission R. & D. and the breeder program in particular.

The nuclear budget as presented offers the subcommittee some difficulties. And I am sure we will be hearing the administration's position on these issues this afternoon.

The issues include the absence of funding for the high temperature gas reactor program, which has been a committee priority for several years; a request of $10 million for activities at the Barnwell nuclear fuel plant, an issue on which this committee and the Appropriations Committee are on record as opposing for fiscal year 1983; the question of proper levels of funding in both the light water reactor safety R. & D. and uranium utilization programs.

In the case of the Breeder Reactor Systems program, which is the chief topic of today's hearing, we have several additional issues.

The distribution of funding in the breeder base technology program among various DOE facilities is of some concern to the subcommittee, and the funding of specific aspects of the safety technology program are also of great concern.

As far as the Clinch River Breeder Reactor project, a topic that is very near and dear to the subcommittee, I believe we are most interested in simply receiving a project status report, and I believe the film that will be shown at tomorrow's hearing, as I understand it, will be most helpful in this regard.

The arguments, pro and con, on CRBR have been gone over now for 5 years, and I think we have rehashed these arguments at the joint energy subcommittee hearings on the ERAB report. I think the record is fairly complete on that score.

Finally, although the water-cooled breeder reactor program is to be terminated, the committee has been presented with a budget request for fiscal year 1983 of $46 million, which is at least $15 million more than we expected, and we have the additional problem of reappropriated funds for fiscal year 1982 exceeding the authorization level in the Omnibus Reconciliation Act of 1981.

We are happy that Congressman Morrison is here now. So, Congressman Morrison, and Shelby, Gordon, and Frank, we do want to welcome all of you here and look forward to your testimony.

Sid, if you would like to proceed to the desk, we certainly welcome your testimony.

You may proceed as you wish, and your entire testimony will be made part of the record.

STATEMENT OF HON. SID MORRISON, A MEMBER OF CONGRESS FROM THE STATE OF WASHINGTON

Mr. MORRISON. Madam Chairman, members of the subcommittee, I certainly would like to thank you for this opportunity to be here with you.

I would like to compliment the members of this subcommittee on wise investments in the past, perhaps greater investments than many realize, in nuclear fuel technology, the breeder concept, and in a balanced energy approach to America's future.

I represent the central part of Washington State, the seat previously held by the distinguished former chairman of this subcommittee, Mike McCormack. His leadership in the nuclear arena has left some mighty big shoes to fill, and I am most appreciative of his continuing guidance and assistance.

The 570-square-mile Hanford nuclear reservation is located in the southeast corner of my district. And since the early days of the Manhattan project, Hanford has been on the cutting edge of nuclear research and development.

Today the Hanford reservation is the home of the Hanford Engineering Development Laboratory, Pacific Northwest Laboratories, the basalt waste isolation project, and Defense programs, including production, enrichment and processing. Every aspect of the nuclear fuel cycle is demonstrated and improved at Hanford.

But Hanford is more than a nuclear wonder. Pacific Northwest Laboratories is engaged in research that ranges from aquaculture to energy storage, and they are in the forefront of much of the Nation's solar and geothermal research.

The Hanford Engineering Development Laboratory, HEDL, was established in 1970 with the defined mission of breeder program development. The breeder mission of HEDL focuses on the fast flux test facility, FFTF, fuel supply, fuel and core development, and the completion of the fuels and materials examination facility, FMEF.

The fast flux test facility is a highly successful investment which has finished its acceptance test program and the first irradiation cycle is on tract for start-up next month. FFTF was authorized in the mid-1960's as a follow-on to the Idaho-based experimental breeder reactor II, EBR–II, to test, and its original intent was to test full-sized fuel and core components and is designed to provide data on systems and instrumentation of size and design prototypic of CRBR and future large commercial breeder facilities.

FFTF sodium loop design differs from EBR–II pool design and represents the heat transfer system developed for CRBR.

Significant differences exist between FFTF and EBR–II in the areas of core design, physical plant characteristics and design requirements. The facility provides the capability to irradiate commercial-size fuel assemblies and other core components in a neutronic and thermal environment typical of commercial fast breeder reactor systems. The planned experimental program will yield long-lived core component designs, fully proved under typical liquid metal fast breeder reactor conditions.

Additional benefits to be gained from FFTF are development of efficient plant operational methods for a large LMFBR-type plant, including proper training and qualification, and optimized maintenance support, as well as plant experience on typical LMFBR components, such as valves, pumps, heat exchangers, and sodium purification systems.

The current 1983 authorization will support a smooth transition into an effectively operating plant with support for the experimental objectives. However, with the present HEDL breeder proposed operating budget of $85 million, it will be impossible to maintain the stated breeder program mission and accommodate the $30 million funding cutback.

Further personnel reductions of 600 to 900 highly trained and experienced people would be required. A large cutback would drastically reduce or eliminate valuable areas of expertise developed over the past decade, which would likely be required at a later date. In other words, after a nearly $2 billion investment in FFTF, the proposed budget threatens the returns from this investment now that it is ready to start producing results.

The other facility, the fuels and materials examination facility, FMEF, authorized in 1978, is currently under construction 1,500 feet west of FFTF. FMEF, closely coupled to FFTF, represents the most cost-effective facility to support the fuel cycle for breeder technology.

As authorized, FMEF is a $188 million project. It is currently 39 percent complete with more than 78 percent of the total estimated cost committed. By October, the main structure will be more than 90 percent complete with overall project completion in excess of 60 percent. The facility is on schedule, within costs and will be ready for beneficial use by 1984.

FMEF will provide the facilities for fuel and fabrication of FFTF and CRBR driver fuels and performance evaluation in support of CRBR licensing and operations. The recent decision by the Nuclear Regulatory Commission to require CRBR licensing makes fuel elements and materials development and evaluation even more critical.

FMEF is a dynamic laboratory capable of supporting a broad range of engineering applications in future years, such as waste treatment and chemical process technology demonstration, which could include plutonium recovery and prototype equipment testing. Also FMEF has been physically sized to accommodate CRBR and other advanced breeder reactor fuel concepts in post irradiation testing and evaluation should the need arise.

DOE's proposed scale down of FMEF, eliminating the post irradiation examination mission and transferring that responsibility to existing facilities would do irreparable harm to the breeder program. I question whether the fuels examination required for future breeder reactors can be done in a satisfactory and cost-effective manner at existing facilities.

In the absence of post-irradiation facilities at FMEF, the major facility where those examinations would take place would be the hot fuel examination Facility, HFEF, in Idaho. It was built in the early 1970's and placed in operation in 1975. It is specifically designed to examine EBR-II test particles and would have to be modified if it were to handle the fuel pins from the FFTF.

As I mentioned, FFTF is 1,500 feet west of FMEF. It can be connected by track to facilitate transfer of irradiated fuel to the examination facilities. HFEF is more than 500 miles from the fast flux test facility and would require transfer of irradiated fuel by highway through Washington, Oregon, and Idaho. FMEF, like FFTF, has been built to meet the Nuclear Regulatory Commission's full natural phenomena criteria, both tornado and category I earthquake. HFEF was built to uniform building code design.

The FMEF facility's capabilities are far superior to HFEF and are worth the investment. And I have listed for the record a series of reasons why the facilities at HFEF are not up to the capabilities of those available at Hanford, including the fact that FFTF and FMEF were basically designed to work together. And the capacity is there for the work that I feel is so necessary as we develop this nuclear fuels technology, particularly for support of the breeder program.

In conclusion, Madam Chairman, and members of the subcommittee, I seriously question the wisdom of the Department's proposed shift in direction of the base breeder program. This direction will severely hamper the timely development of fast breeder technology, and in the long term could prove to be the political demise of the entire program. It is clearly penny-wise and pound-foolish.

Madam Chairman, operation of the modern, versatile, and higher capacity facilities of FFTF and FMEF at Hanford are clearly in the best long-range interest to the national breeder program. The commitment of this subcommittee to America's energy future has been demonstrated by your leadership in nuclear fuel technology. I urge you to stay with the master plan because it is working.

Thank you.

[The prepared statement of Mr. Morrison follows:]

STATEMENT OF HON. SID MORRISON, FOURTH CONGRESSIONAL DISTRICT, WASHINGTON

The Honorable Sid Morrison - March 9, 1982

Madame Chairman, Members of the Subcommittee, I want to thank you for the opportunity to be here. I would like to compliment the Members of the Subcommittee on wise investments in the past, perhaps greater investments than many realize, in nuclear fuel technology and in a balanced-energy approach to America's future.

I represent the Central part of Washington State, the seat previously held by the distinguished former Chairman of the this Subcommittee, Mike McCormack. His leadership in the nuclear arena has left some mighty big shoes to fill and I am most appreciative of his continuing guidance and assistance.

The 570 square mile Hanford Nuclear Reservation is located in the Southeast corner of my district and since the early days of the Manhattan Project, Hanford has been on the cutting edge of nuclear research and development.

Today, the Hanford Reservation is home of the Hanford Engineering Development Laboratory, Pacific Northwest Laboratories, the Basalt Waste Isolation Project, and Defense programs including production, enrichment and processing. Every aspect of the nuclear fuel cycle is demonstrated and improved at Hanford.

But, Hanford is more than a nuclear wonder. PNL is engaged in research that ranges from aquaculture to energy storage and they are in the forefront of much of the nation's solar and geothermal research.

The Hanford Engineering Development Laboratory (HEDL) was established in 1970 with the defined mission of breeder program development. The breeder mission of HEDL focuses on the Fast Flux Test Facility (FFTF), fuel supply, fuel and core development, and the completion of the Fuels and Materials Examination Facility (FMEF).

FFTF is a highly successful investment which has finished its acceptance test program and the first irradiation cycle is on track for start-up next month. FFTF was authorized in the mid-1960's as a follow-on to the Idaho based Experimental Breeder Reactor II (EBR-11) to test full size fuel and core components and is designed to provide data on systems and instrumentation of size and design prototypic of CRBR and future large commercial breeder facilities. FFTF sodium loop design differs from the EBR-II pot design and represents the heat transfer system developed for CRBR. Significant differences exist between FFTF and EBR-II in the areas of core design, physical plant characteristics and design requirements. The facility provides the capability to irradiate commercial-size fuel assemblies and other core components in a neutronic and thermal environment typical of commercial fast breeder reactor systems. The planned experimental program will yield long-lived core component designs, fully proved under typical LMFBR-conditions.

Additional benefits to be gained from FFTF are development of efficient plant operational methods for a large LMFBR-type plant including proper training and qualification, and optimized maintenance support, as well as plant experience on typical LMFBR components, such as valves, pumps, heat exchangers and sodium purification systems.

The current FY '83 authorization will support a smooth transition into an efficiently operating plant with support for the experimental objectives. However, with the present HEDL breeder proposed operating budget of $85 million, it will be impossible to maintain the stated breeder program mission and accommodate the $30 million funding cutback. Further personnel reductions of 600 to 900 highly trained and experienced people would be required. A large cut back would drastically reduce or eliminate valuable areas of expertise developed over the past decade, which will likely be required at a later date. In other words, after a nearly $2 billion investment in FFTF, the proposed budget threatens the returns from this investment now that it is ready to start producing results.

The Fuels and Materials Examination Facility (FMEF), authorized in 1978, is currently under construction 1500 feet west of FFTF. FMEF, close coupled to FFTF, represents the most cost-effective facility to support the fuel cycle for breeder technology.

As authorized, FMEF is a $188 million project. It is currently 39 percent complete with more than 78 percent of the total estimated cost committed. By October, the main structure will be more than 90 percent complete with overall project completion in excess of 60 percent. The facility is on schedule, within costs and will be ready for beneficial use by 1984.

FMEF will provide the facilities for fuel and fabrication of FFTF and CRBR driver fuels and the performance evaluation in support of CRBR licensing and operations. The recent decision by the Nuclear Regulatory Commission to require CRBR licensing makes fuel elements and materials development and evaluation even more critical.

FMEF is a dynamic laboratory capable of supporting a broad range of engineering applications in future years, such as waste treatment and chemical process technology demonstration which could include plutonium recovery and prototype equipment testing. Also, FMEF has been physically sized to accommodate CRBR and other advanced breeder reactor fuel concepts in post irradiation testing and evaluation should the need arise.

DOE's proposed scale down of FMEF, eliminating the Post Irradiation Examination (PIE) mission and transferring that responsibility to existing facilities would do irreparable harm to the breeder program. I question whether the fuels examination required for future breeder reactors can be done in a satisfactory and cost-effective manner at existing facilities.

In the absence of PIE capabilities at FMEF, the major facility where PIE would take place would be the Hot Fuel Examination Facility - North (HFEF/N). HFEF/N was built in the early 1970's and placed in operation in 1975. It is specifically designed to examine EBR-II test articles, and must be modified to handle fuel pins of FFTF length.

As I mentioned, FFTF is 1500 feet west of FMEF. It can be connected by track to facilitate transfer of irradiated fuel to PIE facilities. HFEF/N is more than 500 miles from FFTF and would require transfer of irradiated fuel by highway through Washington, Oregon and Idaho. FMEF, like FFTF has been built to meet the NRC's full natural phenomena criteria, both tornado and category I earthquake. HFEF/N was built to uniform building code design.

FMEF's capabilities are far superior to HFEF/N's and are worth the investment.

* FMEF has full test pin fabrication capabilities -- HFEF has none.
* FMEF has handling capabilities for 20 full length FFTF or CRBR assemblies per year with a seven kilowatt decay heat -- HFEF/N has a maximum decay heat of one kilowatt.
* FMEF has full assembly examination capabilities including neutron radiography and failed fuel examination capabilities for FFTF and CRBR 00 HFEF/N can only examine cropped FFTF assemblies and has no failed fuel capabilities.
* The design and close couple to FFTF allows FMEF to reassemble and qualify test assemblies for reinsertion in FFTF -- this is not possible with current equipment at HFEF/N and the distance between the two sites would introduce added costs and potential program limitations.
* FMEF has the capabilities to nondestructively examine 2000 pins per year of FFTF or CRBR length -- HFEF/N can examine 300 pins per year of FFTF length or shorter.
* FMEF has the capability to do destructive examinations such as metallography, fission gas sampling, and fuel micro structure tests of 300 pins per year -- HFEF/N has no capability to do this testing.

I seriously question the wisdom of the Department's proposed shift of direction in the base breeder program. This direction will severely hamper the timely development of fast breeder technology, and in the long term, could prove to be the political demise of the entire program. It is clearly penny wise and pound foolish.

Madame Chairman, operation of the modern, versatile, and higher capacity facilities of FFTF and FMEF at Hanford is clearly in the best long-range interest of the national breeder program. The commitment of this Subcommittee to America's energy future has been demonstrated by your leadership in nuclear fuel technology. I urge you to stay with the master plan because it is working.

Thank you.

Mrs. **Bouquard**. Thank you very much, Congressman Morrison. We certainly appreciate your testimony and your taking the time to be with us and share your knowledge. And we are looking forward to working with you in this Congress and for your help as you provided last year as well.

Are there questions from the members?

Thank you very much for being with us today.

Mr. **Morrison**. Thank you very much.

Mrs. **Bouquard**. Next we welcome Dr. Brewer, Gordon, and Frank. We appreciate you being with us today.

You may proceed as you wish, Dr. Brewer.

STATEMENT OF DR. SHELBY T. BREWER, ASSISTANT SECRETARY FOR NUCLEAR ENERGY, DEPARTMENT OF ENERGY, ACCOMPANIED BY GORDON L. CHIPMAN, JR., DEPUTY ASSISTANT SECRETARY FOR REACTOR PROGRAMS; DR. FRANKLIN E. COFFMAN, DEPUTY ASSISTANT SECRETARY FOR NUCLEAR WASTE MANAGEMENT AND FUEL CYCLE PROGRAMS; AND KERMIT LAUGHON, CHAIRMAN, TASK FORCE ON REPROCESSING TECHNOLOGY

Dr. **Brewer**. Thank you, Madam Chairman. My colleagues and I are, of course, pleased to make our first appearance of this session before the authorization committee.

I am accompanied today by, on my right, a man whom you know and have worked with in the past, Gordon Chipman, who is the Deputy Assistant Secretary for Reactor Programs. On my left, Kermit Laughon, chairman of a task force on reprocessing technology.

Dr. Coffman, who is the Deputy Assistant Secretary for waste Management, will be here presently.

I have a rather lengthy statement, which I would like to offer for the record.

Mrs. **Bouquard**. Without objection, it will be made a part of the record. You may summarize as you wish.

Dr. **Brewer**. All right. I propose——

Mrs. **Bouquard**. And we are happy to have Mr. Laughon.

Mr. **Laughon**. Thank you.

Dr. **Brewer**. Thank you, Madame Chairman.

The first chart is intended merely to list or itemize the total scope of the Assistant Secretary for Nuclear Energy's responsibilities. There is the reactor development program, which includes the LMFBR, HTGR and light water reactor programs, fuel cycle programs, including breeder and light water reactor processing, breeder reactor fuel fabrication, including the SAF (secure automated fabrication) line.

We also run a $2-billion-a-year enrichment activity, $2 billion in revenues and $2 billion in costs. We also are responsible for the terminal waste isolation program.

Beyond that, the naval reactors program and the light water breeder reactor program are our responsibilities, as is the space reactor program.

Next chart. Our appropriations are three. The energy supply R. & D., which this committee has jurisdiction over, uranium enrichment, and the atomic energy and defense appropriation bill, where the naval reactor program is housed.

I would like to turn next, Madam Chairman, to a discussion of the overall nuclear strategy and the President's nuclear power policy, which he issued on October 8, 1981.

There are four central elements of the President's statement. The first priority is to revitalize the light water reactor industry. As you know, it is beset with institutional, financial, and regulatory problems.

Second, to close the back end of the fuel cycle, that is, process the waste and get it into a geological repository.

Third, continue the scale up of breeder reactor technologies through a sequence of demonstrations, including with EBR–II, FFTF, and Clinch River.

And, fourth, an item which is key to all of these endeavors, commercial reprocessing of light water reactor fuel.

Now, the large chart is intended to link these five elements together.

Mrs. **Bouquard**. Excuse me, Dr. Brewer. I think maybe if we could move it a little bit that way, the members could see it and also the audience.

Dr. **Brewer**. OK. Could we bring it up closer to the members also?

Mrs. **Bouquard**. If you could tilt the other way, then we could see it as well.

Dr. **Brewer**. That is good.

Mrs. **Bouquard**. People who are in the audience, can you all see? I think that is fine.

Dr. **Brewer**. This is a chart which shows the complete integrated nuclear fuel cycle. In red at the top of the chart is the conventional light water reactor fuel cycle, which includes mining, milling and conversion, enrichment of the yellow cake, light water reactor fuel fabrication, power production in the light water reactor, on-site storage of the light water reactor spent fuel, the possibility of an away from reactor storage facility, and, finally, reprocessing of the light water reactor fuel.

Now, from the reprocessing step you see several streams flowing out of it. You have uranium going back to the enrichment step for recycle in the light water system. You see fission product waste being immobilized in green in a waste immobilization facility, which would be adjacent to the reprocessing plant, the possibility, in the circle there, of an interim storage facility for glassified waste and, finally, geological disposal of the waste.

The red, with the exception of the last box, reprocessing, is where we are now. This system, which has been commercialized over the last 25 or 30 years, is, as you know, in some institutional, financial, and regulatory trouble. We have not had orders of reactors for the past 4 or 5 years except foreign orders.

Now, beyond the light water reactor system, the ultimate fission energy system is the breeder reactor, which is a principal interest of this committee. The breeder reactor interfaces with the water reactor at two points: One, we need the plutonium from light water reactor fuel to start up or provide inventory for the commercialization of the breeder.

Likewise, we take depleted tails from the enrichment step and convert that into plutonium 239 in the fast breeder system. And, I must tell you that there is enough depleted tails above ground in known quantities to provide the electrical requirements for this country for several hundred years without mining another ounce.

Now, the breeder system is shown in blue. Fabrication of the plutonium fuel, generation of energy from the reactor itself, spent fuel storage, fast breeder reactor reprocessing and, there, too, we have a waste stream, going to the same waste system as for the light water reactor.

So, in summary, we have four things to do: First, rectify the malaise in the light water reactor industry in red. We have to reprocess light water reactor fuel. We have to close the back end of the fuel cycle in green, dispose of the waste, and, finally, finish developing and deploying the breeder.

I would like to now discuss how we arrived at the fiscal year 1983 budget and in particular several of our criteria. One of the historical phenomena of the civilian nuclear power program is that it has indeed been burdened in the past year with too much money and too little sense of mission and schedule. This is one of the reasons why we are substantially behind the French, the United Kingdom, and the U.S.S.R. in the breeder program.

We have, over the years, developed a lot of little technological sandboxes and hobby shops, and these disaggregated efforts do not add up to a national mission.

President Reagan by his insistence on sharply focusing on four major national objectives has assisted us in reformulating the nuclear strategy and the ultimate program.

I would like to turn now, Madame Chairman, to the issue, which I am sure we will get into in this committee, of the size of the nuclear budget and the charge that the nuclear budget is the big hog at the trough.

Could I have the next chart? This chart shows my total appropriation request, which is $3.4 billion. And, as I said before, only $1 billion of that is the energy R. & D. appropriation. Also shown in the $3.4 billion is the Defense, the Naval reactor's portion of about $.4 billion, and enrichment production operations of about $2 billion, which is fully recovered by revenues.

So, let us start with the $1 billion and go on to the next chart. Of the $1 billion in the energy supply R. & D. appropriation, about a third of that billion is spent on programs which are of an operational or a statutory nature. In other words, it can be thought of as a fixed cost. The waste management program in the 1983 budget is $265 million. That is an operational requirement to close the back end of the fuel cycle. It is an appropriate federal function.

And the size of the budget is determined by how fast or how slowly you want to get on with the program.

Another $50 million is statutory in nature, and that is the remedial actions program. And, finally, we have a small program for space application of nuclear power sources.

So, if we subtract the waste management program from the $1 billion, you are left with a figure of $670 million, which can be characterized as programs which have an ultimate commercialization potention or in a sense are discretionary.

Now, let's talk about the $670 million. And this chart shows the trend between fiscal year 1982 and fiscal year 1983 for the discretionary or commercialization programs. The breeder program is down sharply. The base technology program for liquid metal breeders is down by about $100 million. The light water breeder program is being terminated in fiscal year 1983. The $42 million requested for that program is for termination expenses as well as examining the core from shippingport.

The converter reactor program is down sharply from $96 million to $32 million, and the fuel cycle program is up slightly from $53 million to $60 million.

My point, Madam Chairman, is that the total program is indeed down by 16 percent from fiscal year 1982. My point is that the nuclear program has been cut as well as the other programs in the Department.

Let's flip to the next chart, which is a summary of the major cuts in the nuclear program.

Breeder base R. & D., that is liquid metal breeder base R. & D. down over $100 million.

Converter reactors, down $64 million.

The water-cooled breeder, down $10 million, and on a trajectory toward termination in fiscal year 1983.

The advanced reactor system, that is, the low enrichment reactor fuel projects, has been eliminated from our budget request, but funding will be requested by the State Department.

Finally, Madam Chairman, I submit that the energy R. & D. request, that is, the $1 billion request, represents the appropriate application of Federal expenditures. It is directed at long-term high risk, high public benefit R. & D., which is normally beyond the reach of the private sector. It is clearly and sharply focused on a few major missions that I described. It is reduced compared to fiscal year 1982. So we, too, are experiencing thrift in the nuclear programs. And it is responsive to President Reagan's nuclear policy directive.

I would like to summarize the total budget at this time with one chart, which shows the total trend line from fiscal year 1982 to fiscal year 1983 for the R. & D. appropriation.

Realizing, Madam Chairman, that much of your interest today is in the breeder program, I would like now to ask Gordon Chipman to very briefly summarize the status of the Clinch River breeder reactor project.

[Charts of Dr. Brewer's oral presentation, plus his prepared statement, follow:]

OFFICE OF THE ASSISTANT SECRETARY FOR NUCLEAR ENERGY

NUCLEAR ENERGY PROGRAM

- Conventional Reactor Systems
  - LWR
  - TMI
  - HTGR
  - ARS (RERTR)
- Breeder Reactor Systems
  - LMFBR
  - CRBR
  - WCB
  - Fuel Cycle
- Advanced Nuclear Systems
  - Space and Terrestrial
- Commercial Nuclear Waste
  - Commercial Waste Management
  - Spent Nuclear Fuel
- Remedial Actions
- Uranium Resource Assessment

Energy Production and Power Marketing

- Uranium Enrichment Activities
  - Diffusion Program
  - GCEP
  - Revenues
  - AIST

Defense Activities

- Naval Reactors
  - Plant Development
  - Reactor Development
  - Reactor Operation and Evaluation

OFFICE OF THE ASSISTANT SECRETARY FOR NUCLEAR ENERGY

(FY-1981, 82, 83)
BUDGET SUMMARY
(BA in Millions)

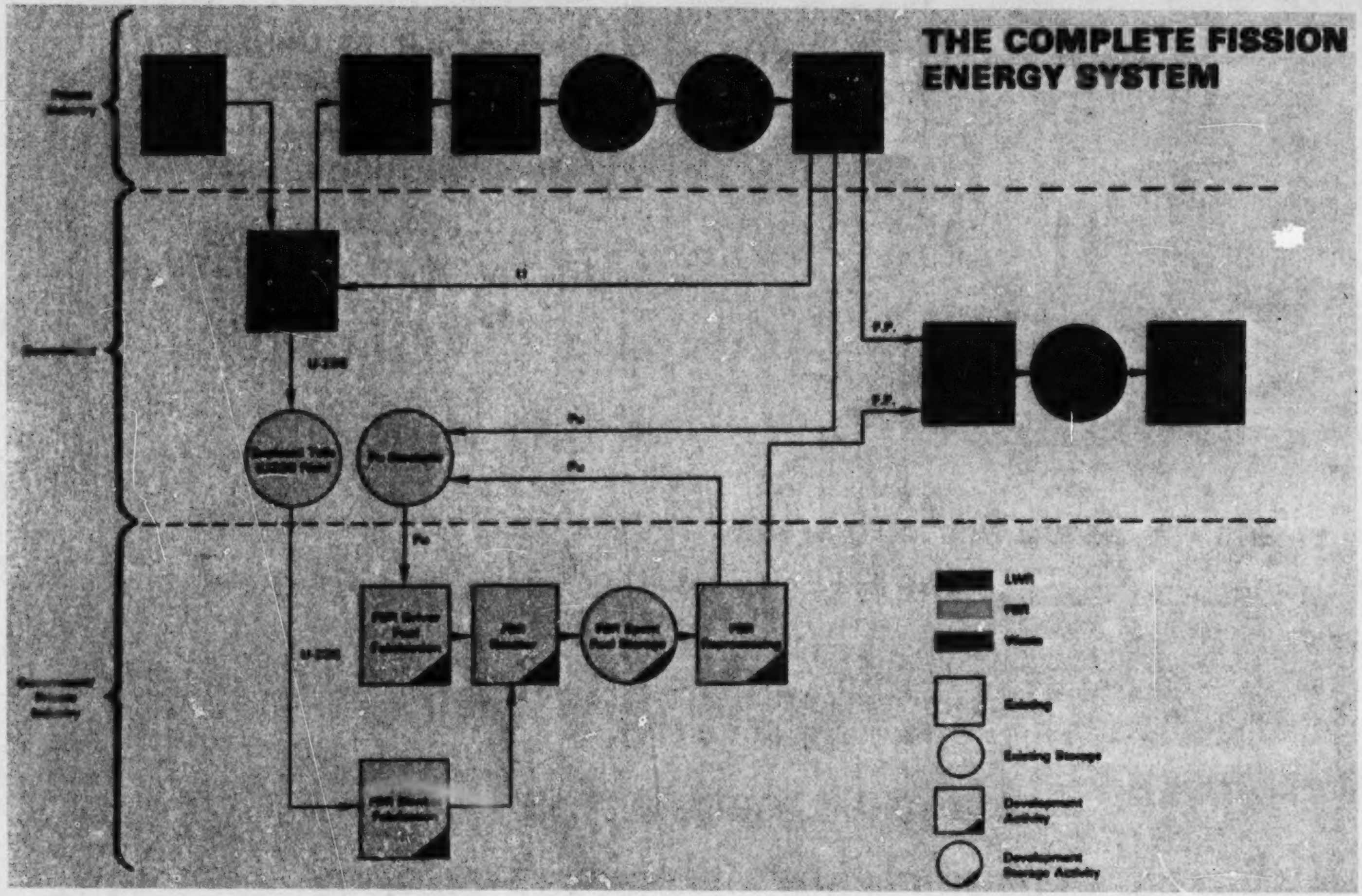
	FY 1981 APPROP.	FY 1982 APPROP.	FY 1983 REQUEST
ENERGY SUPPLY R&D	1,051	1,089	1,017
CONVERTER	83	96	32
BREEDER	611	647	577
ADVANCED NUCLEAR SYSTEMS	40	38	31
COMMERCIAL NUCLEAR WASTE	189	210	81
NUCLEAR WASTE DISPOSAL FUND	--	--	185
REMEDIAL ACTIONS	43	43	50
NUCLEAR FUEL CYCLE	83	53	59
POLICY AND MANAGEMENT	2	2	2
URANIUM ENRICHMENT	-23	-25	0
ENRICHMENT	1,167	1,709	1,930
ADVANCED ISOTOPE SEPARATION TECHNOLOGY	80	86	34
URANIUM RESOURCE ASSESSMENT	31	10	3
REVENUES	-1,301	-1,830	-2,033
DOE RESERVE FOR FY 1984	--	--	66
ATOMIC ENERGY AND DEFENSE	303	359	376
NAVAL REACTORS DEVELOPMENT	303	359	376
TOTAL - NUCLEAR ENERGY	1,331	1,423	1,393

PRESIDENT'S NUCLEAR POLICY

Energy Supply R&D

- Revitalize LWR Industry
- Waste Disposal
- Breeder Reactors
- Commercial Reprocessing

THE COMPLETE FISSION ENERGY SYSTEM



U-238
Pu
Pu
Pu
U-238
F.P.
F.P.
LWR
FBR
Waste
Existing
Existing Storage
Development Activity
Development Storage Activity

ASSISTANT SECRETARY FOR NUCLEAR ENERGY

FY 1983 BUDGET REQUEST

(Dollars in Billions)

OF THE $3.4 BILLION PROGRAM MANAGED BY THE ASSISTANT SECRETARY FOR NUCLEAR ENERGY, $1.0 BILLION IS INCLUDED IN THE ENERGY SUPPLY R&D APPROPRIATION.

TOTAL	**$3.4**
LESS DEFENSE ACTIVITIES (NAVAL REACTORS)	**- .4**
LESS PRODUCTION OPERATIONS (URANIUM ENRICHMENT)	**-2.0**
ENERGY SUPPLY R&D (NUCLEAR FISSION)	**$1.0**

ASSISTANT SECRETARY FOR NUCLEAR ENERGY

FY 1983 BUDGET

(Dollars in Millions)

OF THE $1 BILLION ENERGY SUPPLY R&D APPROPRIATION, $670 MILLION IS FOR PROGRAMS WITH COMMERCIALIZATION POTENTIAL.

TOTAL	$1016
LESS NONCOMMERCIAL PROGRAMS	
o WASTE MANAGEMENT	- 265
o REMEDIAL ACTIONS	- 50
o ADVANCED NUCLEAR SYSTEMS (SPACE)	31
FISSION PROGRAMS WITH COMMERCIALIZATION POTENTIAL	$ 670

ASSISTANT SECRETARY FOR NUCLEAR ENERGY

FY 1983 BUDGET

PROGRAMS WITH COMMERCIALIZATION POTENTIAL

	FY 1982	FY 1983
BREEDER REACTORS	647	578
(CRBR)	(194)	(253)
CONVERTER REACTORS	96	32
FUEL CYCLE	53	60
TOTAL	796	670

TOTAL PROGRAM REDUCTION= 16 PERCENT

REDUCTION OF PROGRAMS OTHER THAN CRBR = 31 PERCENT

ASSISTANT SECRETARY FOR NUCLEAR ENERGY
FY 1983 BUDGET
SPECIFIC PROGRAM REDUCTIONS

	FY 1982	FY 1983	△
BREEDER BASE R&D	367	261	-106
CONVERTER REACTORS	96	32	- 64
WATER COOLED BREEDER	52	42	-10
ADVANCED REACTOR SYSTEMS	4	0	- 4

ASSISTANT SECRETARY FOR NUCLEAR ENERGY
FY 1983 BUDGET
SUMMARY

FY 1983 REQUEST FOR FISSION PROGRAMS WITH COMMERCIALIZATION POTENTIAL UNDER ENERGY R&D

- REPRESENTS LEGITIMATE LONG TERM, HIGH RISK, HIGH POTENTIAL BENEFIT R&D
- IS FOCUSED ON SEVERAL CLEARLY DEFINED MAJOR MISSIONS
- IS REDUCED COMPARED TO FY 1982
- IS RESPONSIVE TO PRESIDENT'S NUCLEAR POLICY DIRECTIVE

ENERGY SUPPLY R&D
(BA IN $ MILLIONS)

	FY 1982	FY 1983
Breeder Systems	647	577
Converter Systems	96	32
Advanced Nuclear Systems	38	31
Remedial Actions	43	50
Nuclear Fuel Cycle	53	59
Commercial Nuclear Waste	210	81
Policy and Management	2	2
Subtotal	1,089	832
Nuclear Waste Disposal Fund	0	185
Total	1,089	1,017

STATEMENT OF SHELBY T. BREWER
ASSISTANT SECRETARY FOR NUCLEAR ENERGY
DEPARTMENT OF ENERGY
BEFORE THE
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
March 9, 1982

Madame Chairman and Members of the Committee, I am pleased to appear before you to discuss the Agency's nuclear fission energy programs. Today I will provide you with an overview of all our programs and discuss in some detail our Breeder Reactor and Nuclear Fuel Cycle Programs. I am accompanied by Gordon Chipman, the Deputy Assistant Secretary for Reactor Programs and Frank Coffman, the Deputy Assistant Secretary for Commercial Waste Management and Fuel Cycle Programs.

The fission energy funding request for FY 1983 is $1,017 million in budget authority, compared to $1,089 million in FY 1982. Distribution of the funds among the program elements is as follows:

	FY 1982	FY 1983
	(in millions)	
Converter Reactor Systems	96	32
Breeder Reactor Systems	647	577
Advanced Nuclear Systems	38	31
Commercial Waste Management	210	81
Nuclear Waste Disposal Fund	--	185 1/
Nuclear Fuel Cycle	53	59
Remedial Actions	43	50
Uranium Enrichment	1,709	1,930 2/
Advanced Isotope Separation	86	34 2/
Uranium Resource Assessment	10	3 2/

1/ Legislation authorizing the Waste Disposal Fund is not included in this request for appropriations.

2/ Offset by projected revenues of $2,033 million.

Madame Chairman, today nuclear energy is providing approximately 12 percent of our country's total electrical supply. This year it is projected to become the second largest generator of electricity, surpassed only by coal. By 1990, as additional plants in the pipeline begin operation, its contribution will increase to between 22 and 25 percent. This is an impressive performance, but I am convinced that nuclear energy can and should contribute far more to our future energy security. The nuclear option is capable of providing hundreds of years of economic electrical power, independent of foreign energy sources, while allowing us to conserve our fossil fuel for other critical applications. Achievement of this goal is predicated on the establishment of a fully integrated fuel cycle and power generation system. The essential elements of this system include a smoothly functioning light water reactor industry, a completed fuel cycle including effective reprocessing and waste management systems, and the timely introduction of the breeder reactor.

On October 8th of last year, President Reagan announced a revised nuclear policy that recognizes both the potential of nuclear energy and the impediments currently restricting its full use. To remove these barriers and allow nuclear power to compete, free of constraint, in the marketplace, several major policy initiatives were announced. They include regulatory and licensing reform, lifting of the ban on commercial reprocessing, accelerated deployment of Federal waste management capabilities, and resumption of breeder development, including completion of the Clinch River Breeder Reactor (CRBR). These directives provide the major thrust of the programs that I will discuss today.

At my confirmation hearing last summer, I pledged my intention of using a "management-by-objective" approach in the planning and execution of our nuclear programs. Adhering closely to this principle, we have directed our research and development to the few large national objectives with which we have been charged. We believe strongly that the resulting, sharply focused programs are both technically sound and cost effective. Our FY 1983 budget proposal eliminates program elements that are not directly related to our major objectives. The remaining elements have been carefully structured to insure maximum effectiveness. As a result, our nuclear activities other than waste management are reduced 16 percent relative to the FY 1982 appropriations. This represents a reduction of 31 percent for programs other than CRBR.

In comparing the budget requests for the individual programs, one distinction should be kept in mind. The amount requested does not necessarily reflect the relative importance of the program. For example, as you will note, the request for our Light Water Reactor Programs is relatively quite small, showing a sizeable decrease from the FY 1982 request. Without doubt, we consider resolution of the issues facing the LWR of primary importance and, indeed, prerequisite to deployment of advanced nuclear options such as the breeder. The reason for the comparatively low request is that LWR technology has been developed, demonstrated, and in use commercially for 25 years.

The need for continued Federal involvement pertains generally to the resolution of regulatory and institutional concerns, with R&D limited to specialized areas such as our TMI cleanup activities. This accident has provided a unique opportunity to obtain important R&D data of generic value to the improved safety of LWRs. Federal Government participation in the cleanup is limited to those tasks that are of broad national benefit or that relate to the Federal responsibilities, under the Atomic Energy Act of 1954, to ensure safe disposal of nuclear waste.

In addition to our research to improve LWR technology, we are responding to the President's policy directive by participating in task forces to identify and alleviate the institutional ills currently confronting the nuclear option. We expect to make recommendations in the near future regarding licensing and regulatory reform and improvement of the climate for nuclear investment.

A final near-term activity that is critical to the continued viability of nuclear power is the establishment of an effective nuclear waste management system. As you know, the past 10 years have witnessed a myriad of paper studies resulting in numerous policy and program redirections, but we have yet to demonstrate the ability to store and dispose of high-level nuclear waste. The lack of decisive action by the Federal Government has allowed this issue to develop into a problem of national concern.

Despite past indecision, several facts are clear. First, nuclear waste is a very real and present phenomenon. Second, we have available technically adequate means for handling this waste. And, third, the longer we allow political vacillations to delay the establishment of an effective waste management system, the greater will be the level of public concern.

In response to the President's call to break these chains of indecision, we have initiated an ambitious, results-oriented nuclear waste program. We are proposing more aggressive schedules for building a test and evaluation facility and for construction of the first licensed waste respository. We have in place a sound technology base--we must now make choices and take action. The number and scope of nuclear waste bills presently under consideration in the Congress indicates that this body, too, is determined that a safe, efficient system be operative as soon as possible.

We are closely monitoring the progress of nuclear waste legislation. One provision that we consider imperative is the establishment of a user-derived fund for major capital expenditures for waste management services, as recommended in our budget. Such a fund would allow those who are benefitting from the electricity generated by nuclear power to pay for the total costs associated with its production. It also would provide the program with the necessary resources to develop and operate repositories without competing for limited funds in the Federal budget. In exchange for upfront financing, we believe the legislation should provide that the Government will agree to assume responsibility for the utilities spent fuel (or high-level waste when reprocessing is available) at some fixed future point.

In my opening remarks I stated that a fully integrated fuel cycle is essential to the complete realization of nuclear fission's potential. Along with other advanced nuclear countries, we recognize the benefits of reprocessing spent fuel and preserving access to this residual energy resource. Additional incentives for developing a domestic reprocessing capability include improved waste disposal characteristics, relief of the spent fuel storage congestion problem, and provision of the plutonium inventory required for breeder reactor demonstration and deployment.

We have been instructed by the President to identify regulatory barriers to commercial reprocessing and to develop recommendations on how to create a more favorable climate for private reprocessing efforts. In carrying out this directive, we have found not only regulatory barriers, but also a number of institutional and economic uncertainties that are impediments to commercial reprocessing. We expect to provide specific recommendations within the next several months for Government actions that will allow the private sector to move forward once again. We remain optimistic that if the Government does its part, the private sector can and will provide a domestic reprocessing service that will restore U.S. leadership, credibility and influence in this critical area.

The final element of an integrated fuel cycle and power generation system is the breeder reactor. The vast potential of the breeder concept was recognized in the mid-1940's by the early pioneers in nuclear fission research. It has been U.S. nuclear development policy from the outset to secure an economic and deployable breeder option for whenever it might be needed. The LWR, resting largely on technology inherited from the naval program, was deployed in the early 1960's and thus became an intermediate step to a breeder economy. It was planned that, ultimately, plutonium stockpiles from reprocessed LWR fuel and depleted tails from enrichment plant operation would launch a breeder economy. The implementation strategy that emerged over the years established a sequence of breeder reactor projects of increasing power rating as the central path of the U.S. breeder research and development program. This plant sequence would provide the organizing principle and schedule for all effort in the program. Prior to

1977, when President Carter deferred breeder development and reprocessing, the planned project sequence was:

- The Experimental Breeder Reactor (EBR-II)--on line in 1964;
- Fast Flux Test Facility (FFTF)--scheduled to be on line in 1980;
- Clinch River Breeder Reactor (CRBR)--scheduled to be on line in 1983;
- A large prototype plant--scheduled to be on line in 1988.

The President, last October, recognized the importance that this breeder technology holds for our future energy security and directed the completion of the Clinch River Breeder Reactor Project. He also recognized the viability of advancing commercial reactor development through progressive scaleup. The approach we are using for CRBR employs not only a scaleup in plant size but a corresponding scaleup in major sodium system components. Research and development in generic breeder system technology, which provides necessary support to plant projects, completes the coordinated strategy. We believe strongly that this approach has invaluable implications for safety, plant reliability, and ultimate plant effectiveness. That industry agrees is evidenced by the significant commitment of 753 electrical utilities, grouped under the Breeder Reactor Corporation, in pledging $257 million to support design, construction, and operation of the Clinch River Reactor.

The decision 5 years ago to defer breeder demonstration has, of course, had a severe impact on CRBR. The effect of the policy debate during the Carter Administration has added approximately $850 million to the cost of the project. More than a day-for-a-day schedule slippage has occurred; in 1977, criticality was scheduled for 1983; at the beginning of the Reagan Administration last year, the reference criticality date was 1990. During my confirmation hearing I pledged to rebaseline CRBR with an aim toward streamlining the project and accelerating the schedule. Since then I have taken steps to expedite all activities on the front end of the schedule. We are also seeking ways to trim the construction time by resequencing construction tasks.

Although the CRBR deferral decision made it impossible to achieve many of our project milestones, efforts in areas not constrained produced notable results. As of January 1, 96 percent of the research and development necessary to build CRBR had been completed, as had 87 percent of the engineering and 60 percent of the equipment procurement.

The next step beyond the CRBR, construction of a large developmental plant, will be primarily the responsibility of the private sector. Current Government involvement is limited to research and development and institutional planning to permit private sector utilization of Government-sponsored efforts on the LMFBR. We believe this is consistent with the Administration's philosophy that the Federal Government should develop long-range, high-risk technology of significant potential national benefit.

A very important lesson that we learned from LWR commercialization is that development of reactor technology must be accompanied by development of supporting fuel cycle technology. This means that to support commercially deployable breeder reactors, we must also develop safe technology for the back end of the fuel cycle.

Accordingly, our fuel cycle R&D program is focused on developing breeder fuel fabrication and reprocessing as part of the overall breeder R&D program. The objective is to develop the technology to a stage that would represent an acceptable economic risk to the private sector. Ultimately, industry must make the choices and bear the responsibility for all aspects of commercial breeder deployment.

Resumption of a leadership role in advanced technologies such as the breeder and reprocessing will enhance our influence in international technical, political, and economic developments as well as our ability to influence world nonproliferation strategies. The availability of advanced technology coupled with renewed efforts to demonstrate the attractiveness of U.S. products on the world marketing scene should substantially increase our viability in foreign commerce.

A key element in our efforts to firmly establish the United States as a reliable supplier of nuclear fuel services is our Uranium Enrichment Program. As you know, the United States presently enriches uranium to the desired U-235 product assay levels in three gaseous diffusion plants located at Oak Ridge, Tennessee; Portsmouth, Ohio; and Paducah, Kentucky. To operate these plants efficiently, we have projected future enrichment requirements to determine the appropriate operating level to meet these requirements. These projections indicate that capacity beyond what is currently available in the gaseous diffusion complex will be required in the 1990's.

Based on the sound technological base which has been developed over the last 20 years, gaseous centrifuge technology is considered the most economical and efficient choice for producing this additional capacity in the required timeframe. In addition to providing separative work at a significantly lower cost than is currently possible, the centifuge process uses but one-twentieth of the energy that gaseous diffusion consumes. Consequently, we are constructing a Gas Centrifuge Enrichment Plant (GCEP) at Portsmouth, Ohio. Construction progress has been excellent. We are on schedule and the total estimated cost, adjusted for escalation, has remained constant.

The enrichment of uranium in the centrifuge plant will begin in 1988 with a capacity of 2.2 million SWU per year available in 1989. Additional production capacity will be added as demand for enrichment services warrants or as economics justify the substitution of gas centrifuge for the more energy-intensive gaseous diffusion. Full production from the 8-building plant is scheduled in 1994.

An advanced enrichment technology, the Advanced Isotope Separation (AIS) process, is being developed. AIS offers the potential advantage of further reductions in capital cost and energy consumption, but it does not enjoy the same technological base as the centrifuge option. When successfully developed, the AIS process could provide new enrichment capacity in the mid-to-late 1990's. Selection of a single process for engineering development from among the three candidate processes will occur in FY 1982 and progress toward a development/demonstration module will continue in FY 1983.

As you know, revenues are received from the sales of enrichment services to domestic and foreign customers. For FY 1983, we estimate these to be over $2 billion. These revenues will more than offset the requirement for appropriations to cover our enrichment activities.

Based on the viability of our operations, there have been suggestions over the years that enrichment activities be transferred to the private sector. We are currently evaluating that option and identifying appropriate procedures should a decision be made to transfer enrichment activities to private industry.

Madame Chairman, if I have conveyed but one message in my foregoing remarks, I hope it is that we do not have business-as-usual programs. We feel that our goals are ambitious but realistic. With the help of Congress, we believe that our programs can make substantial contributions to the safe, efficient generation of nuclear-powered electricity. We do not foresee at this time that our programs would be substantially affected by the President's reorganization proposal.

I would now like to review in some detail the objectives, strategies, and status of the Breeder Reactor and Fuel Cycle Programs.

STATEMENT FOR THE RECORD

BREEDER REACTOR SYSTEMS

Before discussing the details of the breeder reactor systems program and supporting projects, we need to understand the underlying reasons why the breeder is important to this Nation and why it is important for the Government to support its development.

This Nation needs a breeder reactor industrial capability to meet a growing demand for electricity. The breeder reactor can provide less environmental impact than current generation light water reactors (LWRs). It may be the most economical technology for supplying electricity when it reaches technical maturity, and it could become a valuable source of foreign trade benefits. A Federal role is necessary because the costs and risks of development are higher than the private sector can bear, and the benefits are capturable only over a long period of time. The Nation's breeder program has benefited from over 30 years of successful research, development and demonstration support. The achievements are part of a natural progression in size and complexity that we hope will lead to decisions by the private sector on breeder industrialization and deployment.

Unlike insecure foreign oil, breeder fuel, in the form of enrichment plant tails, is already stockpiled, and currently consists of about 260,000 metric tons of uranium. If used in fast breeder reactors, this quantity is sufficient to generate enough electricity to supply the entire United States (at the current rate of demand) for over 700 years. The plutonium required would be obtainable, initially, from reprocessing spent fuel that has already been discharged from light water reactors and, later, from reprocessed breeder reactor fuel.

Recent improvements in energy efficiency, due to conservation and improvements in technology, imply energy growth at a lower rate than has historically been experienced. Nonetheless, it is likely that the historical trends of rising GNP and energy consumption will continue.

Electric energy is more closely coupled to GNP than total energy and accounts for over 10 percent of total energy consumption now. EIA predicts that by the end of the century electricity will account for 17 percent of total energy consumption. Thus, much of the future economic growth will be fueled by increased production of electricity. While national electrical growth rates have decreased from historic high levels, some utilities, such as in the Southwest, are experiencing annual electrical growth rates approaching 6 percent and more. Additionally, new plants will be needed to replace aging facilities and plants that are no longer economic to operate.

Geothermal, solar electric, low-head hydro, and windmills can supply electricity for unique, small-scale applications; but of all the alternatives for electricity production, only coal and uranium offer the potential for economic generation of adequate energy supplies in the foreseeable future. Nuclear energy currently supplies 12 percent of our domestic electrical requirements; with plants being constructed now, nuclear's contribution will grow to 19 percent by 1985 and to 22-25 percent by 1990.

Creating an essentially inexhaustible supply of energy from uranium requires extending the current nuclear technology design and developing the next generation breeder reactors. Continued deployment of current-generation light water reactor plants will ultimately be limited by the availability of economically recoverable uranium ore, currently expected to last between 30 and 50 years, depending on assumptions concerning uranium recovery, cost of production, and electric demand growth.

While other inexhaustible electrical energy sources, such as fusion and solar electric, may become available to compete on an economic, technical, and commercial basis with the breeder, the advanced state of fast breeder technology relative to fusion and solar make it the surest of the inexhaustible supply options. Additionally, continued breeder development provides an important requisite to nuclear growth that will be needed in the near term. No one will be interested in investing in a technology which has no long range future--a future that only breeder reactors can now assure.

Uncertainties in electrical demand growth, uranium resource endowment and recovery cost, LWR plant costs, and other planning assumptions influence ultimate breeder benefits. Economically, breeder benefits derive mainly from low estimated fuel costs, especially due to the fact that enrichment would not be required, and from the relative insensitivity of fuel cycle costs to supply disruptions.

Environmental benefits would accrue from the elimination of mining, milling, and enrichment requirements needed for LWRs. Further, the breeder requires less mining and transportation than coal-fired plants and would not release fossil-fuel emissions to the atmosphere.

While technological feasibility has been demonstrated in a number of small and intermediate size Liquid Metal Fast Breeder Reactors (LMFBRs) built and operated in the United States and abroad, intensive work is required before this technology is established. Future LMFBR progress will rely on the successful development of critical components, operating experience with existing smaller plants, and completion of the R&D tasks underway needed for engineering scale-up.

This LMFBR research, development, and demonstration program is a necessary but costly effort that requires many highly specialized facilities. Combined with the time required to complete the necessary technical work, this program is beyond the investment/ time horizon of any domestic business venture. Due to its high short-term costs and business risks, the research and development can not be funded by the private sector alone.

Reasonable and prudent planning dictates that Federal involvement in LMFBR development progress expeditiously and be geared toward assuring our ability to deploy the breeder when needed. The consequences of early LMFBR development are minor compared to the risk of possible energy shortages and the increased vulnerability such shortages imply, and to the economic penalties in the form of higher priced electricity and possible loss of foreign sales associated with late development. Program delays may destroy the continuity that is essential to any high technology development program; a continuity that has helped propel the French and Japanese programs to the forefront of international competition.

National prestige is also important but is difficult to measure and quantify; it does, however, play an important role in policy decisions. This Nation's prestige, which is derived in large part from our ability to show leadership in all aspects of commercial nuclear technology, including the breeder reactor, provides us with a strong and necessary platform from which to more effectively negotiate nonproliferation goals.

The Federal role in the future of breeder reactors is to conduct the necessary research and development such that the potential benefits of the breeder can be captured by private industry at a venture risk level that is consistent with acceptable business endeavors. The responsibility for industrialization and deployment will rest with the private sector.

The goal of the breeder program is to ensure that this long-term electricity supply option is available on a prudent time scale.

To accomplish this goal, the U.S. LMFBR program will develop the technical, engineering, safety, environmental, economic, licensing, and industrial data base required to transfer design, construction, and operation capabilities of future LMFBR powerplants to the private sector. The program consists of three broad elements: (1) construction and operation of developmental plants, (2) a supporting base technology program, including test facility construction and operation, and (3) supporting fuel cycle program. The program draws upon experience of the water cooled breeder reactor technology development program.

The first two elements are closely integrated and are directed at breeder powerplant development, while the fuel cycle effort will provide the basis for integrating breeder reactors into an existing and expanded nuclear energy economy. A broader description of these elements follows.

Plant Development: To bring LMFBR technology to a point of acceptable commercial risk requires that it be advanced and confirmed by constructing and operating plants in increasing larger sizes. This approach was followed by the Atomic Energy Commission in cooperation with the electric utilities to achieve the successful commercialization of LWRs, and is being used by the major foreign breeder development programs. The LMFBR program has successfully constructed and operated the 20 MWe EBR-II and the 133 MWe equivalent Fast Flux Test Facility (FFTF).

The Agency is proceeding with the 375 MWe Clinch River Breeder Reactor Plant (CRBRP), and we are entering a new phase in which Government is encouraging and supporting construction of a large pre-commercial development plant to follow Clinch River that will be principally private-sector funded.

Base Technology: The role of base technology is to develop information necessary to reduce technical uncertainties to levels acceptable to private industry for further development in key technology areas. It is concentrated in the area of safety, physics, reactor control, coolant flow, heat transfer, and core and fuel development that are within existing Federal capability but beyond the capability of the private sector. The program has been modified to reflect reduced budget requests, and the increased role projected for the private sector in large plant demonstration projects. Specifically, we have consolidated a number of activities, eliminated contractor participation in certain areas, shut down some facilities, and reduced the work level across the board.

Test Facilities: Test facilities are provided to advance technology development through the proof test stage of components and systems critical to the success of reactors in the size range of interest to utilities. The operational objectives are to provide, maintain, and operate, including site support, essential breeder reactor program facilities to meet program requirements and schedules established by projects and other breeder technology elements. Test facility operations are being redirected, through shutting down the Engineering Test Reactor after completion of current tests, consolidation of all physics testing into the Zero Plutonium Power Reactor, and through broadening the role of the Fast Flux Test Facility (FFTF) towards operability and maintainability of the plant, in addition to its use as a fuel test facility.

Fuel Cycle Program: The fuel cycle program is closely coordinated with reactor and technology programs to assure that fuel cycle needs of the overall LMFBR program are met.

Water Cooled Breeder: The goal of this program is to develop technology for significantly improving the efficiency of nuclear fuel resource utilization by water cooled reactors. The Deputy Assistant Secretary for Naval Reactors will testify separately on this program.

A discussion of each nuclear reactor program follows. The budget request for the LMFBR program is summarized below:

	(B/A $ in Millions)	
	FY 1982	FY 1983
CRBR	193.9	252.5
Large Developmental Plant	15.0	--
LMFBR Base Program	376.1	270.6
Program Direction	10.3	12.4

CLINCH RIVER BREEDER REACTOR PLANT PROJECT

To bring LMFBR technology to a point of acceptable commercial risk requires that the technology be advanced and confirmed by constructing and operating plants of increasingly larger sizes. The U.S. LMFBR program has successfully constructed and is operating EBR-II, a 20-megawatt electric plant located in Idaho and the Fast Flux Test Facility, a Hanford, Washington, facility equivalent in size to a 133-megawatt electric plant. As you know, the next LMFBR plant in this deliberate sequence of plants of increased size is the Clinch River Breeder Reactor Plant (CRBRP). This 375 megawatt electric plant is a joint undertaking of the U.S. Government and 753 electric systems from the public, private, municipal, and cooperative sectors of the utility industry. Its size represents a technically significant yet prudent scale up in plant technology. The CRBRP is to be constructed in Oak Ridge, Tennessee, where it will be operated as part of the TVA electricity supply network. In addition to fulfilling its principle objective of advancing breeder technology, the plant will produce electrical power sufficient to meet the residential needs of 200,000 people.

The importance of this project is widely recognized. President Reagan in his October 8, 1981, policy statement on nuclear power stated that completion of the Clinch River plant is essential to ensure our preparedness for long-term nuclear power needs. The CRBRP will provide significant technical information from the results of the plant design, fabrication of plant components, safety, licensing, construction and plant operating experience. Congress has long recognized the importance of the CRBRP as evidenced by its continued support of the project through the years. Professional societies, labor, and other organizations have stated their support for the CRBRP. Included, among others, are the following organizations: the AFL-CIO, the Edison Electric Institute, the American Society of Professional Engineers, Scientists and Engineers for Secure Energy, and the American Association of Engineering Societies. Foreign support has also been received.

Many objections to the CRBRP rest on the assumption that the United States will not need a major new source of electricity. That assumption rests on often-cited claims that demand is decreasing, but demand for electricity has not decreased; rather it is increasing, albeit at a slower rate. Even the current relatively slow annual growth rate will require a doubling of the Nation's impressive 630,000 megawatts of generating capacity every 25-35 years.

The Clinch River design is up-to-date. The original design which was based on guidelines generated from a consensus of technical, industrial, and government groups, has been updated to reflect current regulatory requirements and new breeder developments in the United States and abroad. The current Clinch River design is therefore at the forefront of world breeder technology.

In spite of the delay over the last 5 years, substantial progress on this project has already been made. Plant design is approximately 90 percent complete. Most of the major equipment is either on order or has already been completed. Significant licensing progress is being made and preparation for site work is now under way. We have moved aggressively in response to the Administration's firm support for this project and the consistent intent of Congress as expressed in FY 1982 legislation, that this plant be completed as expeditiously as possible. I would like to highlight some of the important actions that we have taken.

The Nuclear Regulatory Commission's (NRC's) environmental and safety reviews of the project have been resumed and are currently proceeding very satisfactorily. It is expected that the NRC staff will complete its environmental review this fiscal year and complete its safety review in Fiscal Year 1983. These reviews will be followed by public hearings with the expectation that a construction permit will be issued in mid-1984.

Other important initiatives which have been taken include improvements in the organizational structure of the project and in the contractual arrangements with our principal contractors, planned placement of a fixed price contract for plant steam generators, and the establishment of a schedule to bring the plant to criticality in late 1988. These actions will enable us to proceed effectively towards expeditious completion of this project.

Design and equipment fabrication will continue to progress towards completion. Design will be approximately 95 percent completed and virtually all drawings required for plant construction will be finished by the end of the year. We will continue to add to our already substantial inventory of completed hardware. Deliveries planned for FY 1983 include the polar and building service cranes, thermal insulation, thermal transient valves, and the protected air cooled condenser. We will also continue the fabrication of other equipment, including steam generators, pumps, and the ex-vessel transfer machine.

It is time to move with this project, which the Congress has supported so consistently. Much has been accomplished during the past year to pave the way for completing this project as soon as possible and our efforts will continue to focus on this objective. Success will require the continued support of Congress and appropriation of the full funding requested for Clinch River. With your support, we can begin to realize the benefits of successful operation of this advanced LMFBR plant.

LARGE DEVELOPMENTAL PLANT

At present, breeder technology has been developed to a point where there is a substantial level of confidence that large

LMFBR's can be successfully introduced when needed to meet future U.S. energy needs. However, substantial technical and engineering uncertainties exist with regard to the reliability of performance of certain elements of breeder plants. The resulting technical and economic risks of proceeding to the pre-commercial demonstration of a large breeder reactor at this time is unacceptably high for the private sector. The CRBRP and the breeder base technology program are directed at reducing these technical and engineering uncertainties to acceptable levels such that the private sector could undertake this next major step. This step is important in demonstrating the acceptability of these risks to private industry and will specifically require the design, construction, and operation of a large developmental breeder plant at near-commercial scale.

With regard to activities supporting a large developmental plant, DOE efforts are entering a new phase in which the Government will provide support and encouragement to a newly initiated utility activity to define the design, cost, schedule, and implementation plans for a developmental plant whose construction will be principally funded by the private sector. A major activity that will be undertaken in concert with the private sector is an effort to develop international participation in the project so as to minimize program costs and to allow maximum utilization of international technological advances.

If satisfactory progress is achieved in FY 1982 in development of cooperative arrangements with foreign nations and the private sector, continued Government support for this activity in FY 1983 will be provided.

In this light, the Large Developmental Plant (LDP) project is proceeding in fiscal year 1982 with the advanced conceptual design, preparation of detailed cost and schedule estimates, and the definition of the research and development required to support a large scale LMFBR plant. Highlights of this project during the last year include efforts to optimize the overall plant design and to reduce the estimated plant capital cost. Also, the design and research and development results of the Clinch River project and the breeder base program are being incorporated into the large plant advanced conceptual design.

Currently, as the LDP proceeds, we are attempting to develop the framework for beneficial cooperation in a large LMFBR plant project with the private sector and with various foreign countries. Progress in this area to date is very encouraging. If we can successfully achieve broad cooperation in a large plant project, the risks and costs of proceeding with the development of the breeder could be significantly reduced. Cooperative international arrangements also offer the potential for developing a sound basis for institutional fuel cycle arrangements needed to support the breeder.

LIQUID METAL FAST BREEDER REACTOR BASE TECHNOLOGY PROGRAM The role of this program is to establish a sound technology base to enable the private sector to proceed with industrialization and deployment of the LMFBR. The technology program has undergone some modifications to make possible a reduced FY 1983 budget request. To achieve the necessary economies we have consolidated a number of activities and eliminated contractor participation in certain areas. We also will shut down some facilities and reduce the work level across the board. Nevertheless, we believe that we still can manage the development of a sound technology base, although at a somewhat reduced pace and scope.

The private sector will make the determination when the LMFBR technology will be deployed, but such deployment will take place only when the industry feels that the Government has brought the technology to maturity.

The activities required to achieve that goal are:

- Continued operation of Breeder Reactors of increasing size to provide the necessary overall system interaction and performance experience.

- Development through the proof test stage of certain components critical to the success of reactors in the size range of interest to utilities.
- Generic research and development, within existing Federal capability, but beyond capability of the private sector. This research and testing will develop solutions and prove their performance for use in reactor design and operation. Research and development is performed in the areas of safety phenomena required for the regulatory process, physics, and control performance for reactor core design, earthquake and natural hazard resistance, and verified engineering design tools in the flow, heat transfer, and structural areas appropriate to large scale plants, and core components including fuels.

I will now describe each technology area in detail:

ENGINEERED SYSTEMS AND COMPONENTS

Engineered Systems and Components program encompasses the development of component technology to the point where the future economic and technical risks of designing, building and operating safe, reliable, and economic breeder reactor components are acceptable and can be undertaken by the private sector.

Experience with breeder reactor plants in this country (EBR-II and Fermi) and abroad (PFR, Phenix, BN-350, BN-600) has shown that heat-transport components have been the major source of plant operational deficiencies. Thus, development emphasis is on technology in support of unproven but essential components such as steam generators and main coolant pumps. Also, the requirements for components beyond CRBRP and FFTF are different and, in some cases, more severe necessitating significant additional technology development and testing. Supporting development in areas such as vibration and mixing are carried out to successfully complete component technology development.

Of the major components, the steam generator presents the most challenging problem. Demonstration of a proven technology base capable of assuring the availability of steam generators for future breeders has not yet been fully achieved, either in this country or abroad.

FY 1982 accomplishments in the Engineered Systems and Components program include:

o Assembly of the tube bundle of the single-wall tube model steam generator will be complete.

o Post-test examination of the double-wall tube, seven tube model will be complete.

o Assembly of the shell of the double-wall tube model steam generator will begin.

o Fabrication of the two-stage primary pump test unit will continue.

- Testing of the intermediate pump test unit shaft seal will be completed.

- Large leak sodium-water reaction testing and evaluation will be completed.

FY 1983 activities will be as follows:

- The final design analysis and fabrication of the single-wall tube helical coil steam generator model will be completed, and the model will be shipped to the Energy Technology Engineering Center (ETEC) for sodium testing.

- Fabrication of the two-stage primary pump test unit will be completed.

- Testing of acoustic leak detection systems during the CRBRP prototype steam generator test will be completed.

FUELS

The Fuels program includes fuel system development and assurance of fuel supply for the LMFBR. Two major goals are pursued:

- Provide safe, reliable, long-lifetime cores for fast breeder reactors through development, testing and qualification of mixed oxide fuel, blanket, and absorber components and verification of performance analysis methods required for LMFBR core design. Development of such core components requires selective development of cladding and duct alloys that exhibit maximum stability in the breeder core environment.

- Develop an adequate fuel supply capability, to support the CRBRP, the FFTF, and future LMFBRs as required, that reduces personnel radiation exposure, enhances special nuclear material safeguards, and provides high quality, lower cost fuel.

Significant Fuels program accomplishments through FY 1982 include:

- Completion of successful testing of over 3000 fuel pins in the FFTF operations. Over 400 of these fuel pins have been tested beyond their design lifetime.
- Completion of more than 50 mixed-oxide fuel pin transient tests for establishing overpower operating capability of reference FFTF/CRBRP fuel.
- Fabrication of four complete core loadings of high quality FFTF driver fuel pins.
- Development of the fuel fabrication processes and automated equipment required for integration into a remotely operated fuel fabrication line.
- Completion of the advanced conceptual and preliminary designs of the Secure Automated Fabrication (SAF) line. This line is designed to provide FFTF driver fuel while further developing and demonstrating technology to reduce personnel irradiation

exposure, to enhance special nuclear materials safeguards (accountability and physical protection), and to improve fuel quality and cost.

Key Fuels accomplishments in FY 1983 will include:

- Qualification of the reference FFTF/CRBR mixed oxide fuel system through FFTF testing to burnup levels of approximately 60,000 MWD/T (goal burnup is 80,000 MWD/T) will be completed.
- Detailed engineering design supporting fully-integrated SAF line operation in the Fuels and Materials Examination Facility (FMEF) will be continued. Procurement of SAF line equipment will continue. Integration testing of specific subsystems will continue in preparation for initiation of system installation in FY 1984.
- Demonstration tests in EBR-II and TREAT of oxide fuel pins with 2-year lifetime capability will be completed.
- Testing of an oxide fuel system and related cladding and duct materials with a 2-year lifetime capability will be initiated in FFTF.

MATERIALS AND STRUCTURES

Materials and Structures encompasses the development of design methods and criteria, materials properties data, and processes to establish an adequate technology base to support design, construction, and licensing of plant systems and components.

Program products include data, design rules and technical guidelines as documented in reports, Nuclear Energy Standards, consensus standards, and the Nuclear Systems Materials Handbook.

Planned accomplishments in FY 1982 in the Materials and Structures program include:

- Complete analysis of life test results for the CRBRP materials.

Planned accomplishments in FY 1983 include:

- Complete analysis of tests to confirm seismic design procedures for piping systems.

SAFETY

The Safety program is directed to the public safety considerations associated with LMFBR's. The mission of the program has two elements: 1) providing an adequate data base for licensability and assessment of risk to the public, and 2) beneficially influencing safety design features of LMFBR's. The efforts lie in two main areas: 1) prevention of accidents and 2) mitigation of accident consequences.

Some elements of the program have been consolidated, reducing the number of contractors involved. Reductions have been made primarily by consolidation of activities in the in-pile experiments program in TREAT. This program provides essential data on behavior of fuel and coolant during postulated accidents. Work will continue on upgrading the TREAT reactor to provide essential improvements in safety testing capabilities. Additionally, a viable program of operational safety experiments will be maintained utilizing the EBR-II reactor facility.

The consolidated program activities are organized along Lines of Assurance (LOA's) as a technique of management and as a means for communication and introduction of risk concepts.

Safety R&D in LOA-1 involves demonstration of reactor system reliability in preventing the occurrence of accidental events requiring prompt reactor shutdown, and demonstration of highly reliable reactor shutdown and shutdown heat removal should such events occur. LOA-2 R&D aims to demonstrate that faults in the shutdown and shutdown heat removal systems, and local faults within the core itself, can be accommodated with only limited damage to the core.

Safety R&D in LOA's 3 and 4 covers investigation of the potential of hypothetical core-disruptive accidents (HCDA's) to damage reactor and containment structures, development of engineered systems to reduce potential releases of radioactive material from containment, and studies of the inherent attenuation of airborne radioactive materials.

Major Safety program accomplishments through FY 1982 include:

- Complete reliability assessment of LMFBR shutdown systems and shutdown heat removal system.

- Continue development of man-machine interface programs leading to improvements in LMFBR control room design.
- Continue development of self-actuated shutdown systems.

In FY 1983, activities will include:

- In the man-machine interface area, evaluation of the plant status and maintenance control system at FFTF will be continued, and progress in the development of transition control and safety function monitoring systems will be reported.
- Progress in the evaluation of the potential for internal fuel motion to effect reactor shutdown under extreme accident conditions will be reported. The report will summarize experiments and analyses already performed, and recommend further work, where necessary.
- A series of natural circulation tests in EBR-II will be initiated. These experiments will utilize specially instrumented in-core test assemblies to measure natural circulation performance under increasingly severe reactor shutdown transient conditions.

PHYSICS

The Physics program provides analytical design capability and data needed for the development and operation of safe, efficient LMFBR plants. Analytical capabilities are provided in the form of computer codes for interpretation of physics experiments and application in LMFBR design. Physics data include cross sections, nuclear decay characteristics, and a wide range of integral spectral and spatial measurements in critical assemblies, shielding mockups, and operating reactors.

Major Physics program accomplishments through FY 1982 are:

- Analyses of critical experiment mockups of CRBR sized heterogeneous cores, including fuel loading, power distribution, control worths, and detailed safety-related data.

- Analysis of major shielding requirements of a developmental LMFBR.

FY 1983 planned Physics accomplishments include:

- Apply sensitivity analysis and analyze benchmark measurements of FFTF fuel burnup to improve the design data base and fuel management capability for CRBRP.

- Complete preliminary evaluations of space dependent kinetic effects and perform benchmark critical experiments on Zero Power Plutonium Reactor (ZPPR) to improve understanding of physics performance of heterogeneous cores.

- Continue FBR assessments program to treat power and reaction rate distributions and Doppler reactivity effects. Incorporate results of assessments program into data files for FBR analysis.

- o Perform shielding analyses to confirm performance, cost, weight savings for advanced in-vessel shields.
- o Continue analysis of the reactivity effects associated with mechanical and thermal hydraulic design features of FBR's incorporating data from operating plants.

TEST FACILITIES

The major objectives of the Test Facilities effort are to provide, maintain, and operate, including site support, essential breeder reactor program facilities at Hanford Engineering Development Laboratory (HEDL), Argonne National Laboratory (ANL), and Energy Technology Engineering Center (ETEC) to meet program requirements and schedules established by projects and other breeder technology elements. In addition, our budget request contains the requirements necessary to assure continued safe and efficient operation of the Advanced Test Reactor at Idaho National Engineering Laboratory (INEL) in support of the Naval Reactors program. In meeting these objectives experience in design, prototype testing, construction, operation, and maintenance is provided to plant projects and base technology. Thus a proven baseline for scaling up systems and components is established.

Several significant changes are included in our proposed budget for the Test Facilities effort. First, the focus of the Fast Flux Test Facility (FFTF) operation will shift toward demonstration of the operability and maintainability of a 400 MWt breeder reactor plant. This change in emphasis combined with FFTF achieving routine operations, accounts for the reduction in operating costs for this key facility. Second, we are not requesting any additional budget authority for Fuels and Materials Examination Facility (FMEF) in FY 1983. The FMEF will be completed with provisions for the Secure Automated Fabrication (SAF) line but activities associated with post-irradiation examination (PIE) capability will be terminated. PIE needs currently projected can be accommodated within existing facilities located at HEDL and ANL-West. Third, following completion of the series of the Sodium Loop Safety Facility (SLSF) tests in the Engineering Test Reactor (ETR) in December 1981, efforts were immediately undertaken to insure that activities required to place the ETR into an inactive standby status would be completed in FY 1982. This replaces previous plans to complete this activity in FY 1983 and results in a cost reduction of $3 million for the overall activity. Fourth, steps have been taken to consolidate all physics testing efforts into the Zero Plutonium Power Reactor (ZPPR) and to place several of the smaller ETEC component test facilities on standby.

The Test Facility objectives will be achieved with continued use of cost and schedule control systems and award fee type contracts as applicable to assure contractor performance meets major milestones and efficient use of funds. Where essential services can be performed by industry, maximum use of these industrial services are made in order to continue appropriate industrial support and minimize future disruptive perturbations in laboratory manpower.

WATER COOLED BREEDER

	FY 1982	FY 1983
Water Cooled Breeder	52.0	42.0

The Water Cooled Breeder program's mission is to develop technology for significantly improving the efficiency of nuclear fuel resource utilization by water cooled nuclear reactors used for electrical power generation. The concept being demonstrated is a self-sustaining breeder reactor, cooled and moderated with ordinary (light) water and fueled with uranium-233 and thorium. Successful confirmation of breeding in the Shippingport Light Water Breeder Reactor core will provide the basic technology which would make available for power production about 50 percent of the energy in the Nation's thorium reserves, a source of energy many times greater than the known fossil fuel reserves. This concept is the only known approach using the proven technology of the light water reactor system for increasing fuel utilization efficiency significantly beyond the approximately one percent achievable with present types of light water thermal reactors. The subprograms within the Water Cooled Breeder program in FY 1983 will be: Shippingport Atomic Power Station (SAPS) and Light Water Breeder Reactor (LWBR).

Shippingport Atomic Power Station

The Shippingport Atomic Power Station subprogram's objective is to advance pressurized water reactor technology through testing of advanced reactor concepts. The experience gained from operating the Shippingport Atomic Power Station, the first commercial nuclear reactor power station in the United States, provided the basis for much of the technology leading to present central station light water nuclear powerplants.

The operation of the Light Water Breeder core in the Shippingport plant is an extension of the development work that has been carried out at this facility since its initial operation in 1957. Since start-up, the Light Water Breeder core has performed successfully in both sustained operation at high power and periodic swing-load operations during which reactor power has been varied to meet power load demands. The Light Water Breeder core was released for routine operation to supply power to the Duquesne Light Company distribution system on December 2, 1977. As of December 2, 1981, the core had accumulated more than 24,300 effective full power hours and continues to provide valuable test data.

In October 1982, the Shippingport plant will cease routine power operation with the Light Water Breeder core and end-of-life testing and reactor defueling will begin. Completion of this effort will take approximately two years. The end-of-life testing includes core physics and engineering tests to provide data to use as a reference point in the end-of-life examination at the Naval Reactors Expended Core Facility (ECF). Efforts associated with the defueling process in FY 1983 include: maintaining the necessary plant conditions to conduct the defueling; removing interferences, external head components, and closure head studs; and disposal of removed LWBR components, except for spent fuel. The Shippingport plant will continue to be maintained for the period necessary to complete defueling and shipment of the spent fuel. Upon completion of spent fuel module shipments, the Shippingport Atomic Power Station will be turned over to the Agency's Office of Nuclear Waste Management and Fuel Cycle Programs for decommissioning activities.

Assessment and disposal of components removed from the Shippingport reactor vessel prior to installing the Light Water Breeder core will continue. This includes shipment of the remaining components from Shippingport, and completion of the lower core barrel shipping container.

Light Water Breeder Reactor

The Light Water Breeder Reactor (LWBR) subprogram's objective is to accomplish the following: prove that breeding can be achieved in a light water nuclear reactor using the uranium-233/thorium fuel system; confirm a practical way to use thorium, a plentiful source of fuel for which there has been no major energy-related use; show the feasibility of installing prebreeder and breeder cores of the LWBR type in existing and future pressurized water reactor plants using existing types of plant components and systems; and make the technology developed under the program available to commercial industry. Another technical benefit of this program is the significant improvement in the efficiency of using nuclear fuel resources that is expected to be realized from LWBR technology.

Subsequent to defueling the Shippingport LWBR the spent fuel modules will be shipped to the ECF for a detailed core examination to verify core performance. Core examination is expected to take three-to-four years. If these examinations confirm that the LWBR core performed satisfactorily and bred as predicted, the basic reactor technology will have been established that could make available for power production about 50 percent of the energy potentially available in thorium reserves.

During FY 1983, work conducted under the Light Water Breeder Reactor subprogram will include: conducting end-of-life testing; disassembling fuel modules; shipping spent fuel; and preparing for core examinations. Specific efforts to be carried out include: conducting comprehensive physics and engineering tests to characterize the LWBR core at the end of its life; completing defueling equipment receipt and checkout; training of laboratory personnel for all phases of defueling and shipping; training personnel at ECF to receive the spent fuel, disassemble fuel assemblies, perform core examinations, and nondestructively assay fuel rods; cutting closure head seal welds; disconnecting and removing the suspended fuel modules from the reactor vessel head; partially disassembling fuel modules at Shippingport and initiating shipment of the spent fuel; and receiving and commencing fuel disassembly at ECF.

NUCLEAR FUEL CYCLE PROGRAM

The Nuclear Fuel Cycle Program includes technology for the safe and economic closing of the back-end of the light water reactor (LWR) nuclear fuel cycle, R&D on the breeder fuel cycle, and the development of waste forms that would meet requirements for safe disposal in a geologic media. Additionally, the program includes the identification and elimination of technical and institutional impediments to commercial reprocessing. Since additional spent fuel storage capacity will be required prior to the availability of commercial reprocessing services, the Agency, industry and utilities will participate in joint demonstration programs leading to the licensing of alternative storage techniques to enhance existing capabilities. The Budget Request for this program is $59.3 million, as compared to $52.7 million in FY 1982. The subprogram elements include: Reprocessing Technology, Waste Treatment and Storage Technology, and Spent Fuel Technology.

- Reprocessing Technology

  The fuel reprocessing research and development program provides for technology development in commercial fuel reprocessing and recycle. Process improvements for light water reactor fuel reprocessing are being addressed as are the more stringent requirements associated with reprocessing fast breeder fuels. The technical program is focusing on the development and demonstration of reprocessing technology that will provide for reduced occupational exposure, improved environmental protection, enhanced operational safety and reliability, acceptable economics, and improved safeguards.

In FY 1982, equipment will be installed and integrated into systems in the Remote Operations and Maintenance Demonstration (ROMD) section of the Integrated Equipment Test (IET) facility and tested for remote maintenance performance.

In FY 1983, the Integrated Process Demonstration (IPD) section of IET will be put into service. In addition, the IET will be completed for large-scale development and non-radioactive testing of reprocessing equipment and services. The modular shear will be completed and installed in ROMD as will the automatic in-cell samplers. Engineering development of remote maintenance equipment will continue. Efforts will also proceed on safeguards, spent fuel, plutonium and waste handling development at the Barnwell facility in South Carolina. Design studies of an advanced head-end facility colocated with an existing LWR reprocessing facility will continue.

- Waste Treatment and Storage Technology

  The program is directed toward the safe handling, treatment, and interim storage of fuel cycle wastes prior to their permanent disposal. A significant activity is the selection of a commercial waste form and process that the Federal

Government would accept from a reprocessing operation. The Agency will continue work on transuranic waste management. Because management of transuranic and high level waste has similar needs and objectives there will be close interaction and mutual support between the programs. Emphasis will be placed on the development of automated and remote operations for the higher radiation levels associated with commercial transuranic waste. The Agency will also initiate the conceptual design of a facility to provide interim storage of waste from reprocessing operations.

- Spent Fuel Technology

Analyses indicate that utilities will require interim spent fuel storage capacity in addition to their present pool-type storage. While the Agency believes that this interim storage is the responsibility of the private sector, we also see the feasibility of Government assistance and support in the commercial application of alternative storage technologies. Our experience has indicated the interim storage needs of commercial reactors can best be met by technologies such as rod consolidation and dry storage in casks. Thus, we are working with utilities with near-term storage problems to explore methods of applying these technologies to their particular needs.

The Agency's role in these cooperative efforts is to support utility license applications for rod consolidation and dry cask storage. Accordingly, we will develop generic licensing information that can be used by all utilities; provide removable or reusable equipment, such as a temporary storage cask or fuel disassembly equipment, for use in licensed storage operations; and conduct unlicensed storage demonstrations at a Government site with utility supplied fuel and casks in support of Nuclear Regulatory Commission requirements.

The utilities are expected to provide the reactor site and spent fuel used in the licensed storage operations. In addition, the utilities and private industry would provide the site specific equipment, personnel, and licensing documentation required and also any transportation services that are required.

The Agency will begin licensed use of boiling water reactor (BWR) fuel disassembly and rod consolidation during FY 1983 through a cooperative agreement with the Tennessee Valley Authority. Licensed use of a storage-only cask, procured by the Agency in FY 1982, is planned to begin in FY 1983.

Except for data on storage of consolidated rods in casks, we feel that a sufficient data base exists today to pursue licensing of rod consolidation and dry storage technologies. We issued a report in FY 1982 on the technological status, licenseability, and economics of dry storage.

Mrs. BOUQUARD. Thank you very much, Dr. Brewer.

Gordon, please proceed with your testimony.

Mr. CHIPMAN. Thank you, Madam Chairman.

To bring the LMFBR technology to a point of acceptable commercial risk requires that the technology be advanced and confirmed by constructing and operating plants of increasingly larger size. The U.S. breeder program has successfully constructed and operated EBR-II, which, as you know, is a 20 megawatt electric plant in Idaho, and, of course, the fast flux test facility, which Congressman Morrison previously referred to.

The next LMFBR plant in this sequence is the Clinch River plant, rated at 375 megawatts of electric power. It is a joint undertaking of the U.S. Government and 753 electric utilities from the private, public, municipal, and cooperative sectors.

This size represents a technically significant yet prudent scale-up in the plant technology. Clinch River is to be constructed in Oak Ridge, as you know, where it will be operated as part of the TVA electrical supply network. And in addition to supplying the basic R. & D. information, which is the main purpose for this project, it will produce enough electricity to supply the homes of 200,000 people.

The importance of this project is widely recognized. President Reagan in his October 8, 1981, statement on nuclear power stated that completion of Clinch River is essential to insure our preparedness for long-term nuclear power needs. Clinch River will provide significant technical information from the results of plant design, fabrication of components, safety, licensing, construction, and plant operating experience.

The Congress has long recognized the importance of Clinch River, as evidenced by its continued support of the project through the years. Professional societies, labor, and other organizations have also stated their support. Included among these are the following: AFL-CIO, the Edison Electric Institute, the American Society of Professional Engineers, Scientists and Engineers for Secure Energy, and the American Association of Engineering Societies. Foreign support has also been received, as you know.

Many objections to Clinch River rest on the assumption that the United States will not need a major new source of electricity. That assumption rests on often cited claims that the demand is decreasing, but demand for electricity has not decreased, rather, it is increasing, albeit at a slower rate.

Even the currently relatively slow annual growth rate for electricity will require a doubling of the Nation's impressive 630 gigawatts of installed generating capacity every 25 to 30 years.

The Clinch River design is up to date. The original design, which was based on guidelines generated from a consensus of technical, industrial, and government groups, has been updated to reflect current regulatory requirements and new breeder developments in the United States and abroad.

The current Clinch River design is, therefore, at the forefront of world breeder technology. In spite of the delay over the last 5 years, substantial progress on this project has already been made. Plant design is approximately 90 percent complete.

Most of the major equipment is either on order or has already been completed. Significant licensing progress has been made and preparation for site work is underway. We have moved aggressively in response to the administration's firm support for this project and the consistent intent of Congress as expressed in the fiscal year 1982 legislation that this plant be completed as expeditiously as possible.

I would like to highlight some of the important actions that we have taken in this regard. The NRC's environmental and safety reviews of the project have been resumed and are currently proceeding very satisfactorily. It is expected that the NRC staff will complete their environmental review this fiscal year and complete the safety review next fiscal year. These reviews will be followed by public hearings with the expectation that a construction permit will be issued in mid—1984.

Design and equipment fabrication will continue to progress toward completion. Design by the end of fiscal year 1983 will be approximately 95-percent complete and virtually all drawings required for plant construction will be finished by the end of the year.

We will continue to add to our already substantial inventory of completed hardware.

Deliveries planned in 1983 include the polar and building service cranes, thermal insulation, thermal transient valves, and the protected air-cooled condenser. We will also continue the fabrication of the equipment, notably steam generators, pumps, and the ex-vessel transfer machine.

It is time to move with this project, which the Congress has supported so consistently. Much has been accomplished during the past year to pave the way for completing Clinch River as soon as possible, and our efforts will continue to focus on this objective. Success will require the continued support of Congress and appropriation of a full funding request for Clinch River.

With your support, we can begin to realize the benefits of successful operation of this advanced breeder plant.

Thank you, Madam Chairman.

Mrs. BOUQUARD. Thank you very much, Gordon. Do you have other witnesses, Dr. Brewer?

Dr. BREWER. No, ma'am. Mr. Coffman has joined us, and he is in charge of the waste management program.

Mrs. BOUQUARD. We welcome you, Mr. Coffman. Thank you very much. That was very excellent testimony.

Our breeder reactor systems program is a very integral part, as you know, of our total nuclear energy strategy to revitalize our nuclear industry, as the President has stated.

If DOE concurs, how does this breeder base program as presented in the budget achieve this goal with this $106-million reduction, Dr. Brewer?

Dr. BREWER. As you know, we have reduced the breeder base budget under very tight budget limitations. We have reduced it by about $106 million. The breeder base technology program, Madam Chairman, is one of two major elements of the total breeder program, the first element being the progressive scale-up of plant projects, such as the sequence of EBR-II to FFTF to Clinch River and beyond.

Those are plant projects or demonstration.

And there are the fuel cycle demonstration projects, such as the SAF line at Hanford, the fabrication line. Ultimately there will be a reprocessing demonstration, where the research is being done at Oak Ridge.

Now, those are projects. Those are intended to improve the technology, and scale it up to commercial sizes. Underlying those projects, which are the central path of the program, is what we call the breeder base technology program, and this involves fuels research, the materials research, the testing of sodium components, but core physics and that sort of thing.

The base technology program elements ideally should be linked very closely to the requirements of the projects. Otherwise there is waste. In making the reduction by $106 million in the breeder base program, we had to make some painful reductions in the program. But I still feel that we have a viable base technology program. We have had to reduce the emphasis, the previous emphasis, on fuels research in order to protect the projects, such as FFTF and Clinch River.

Mrs. BOUQUARD. Are these ramifications significant in that we are falling behind France and Japan and the Soviet Union in developing this breeder option?

Dr. BREWER. If you had said why not take the $106 million out of one of the major projects, such as Clinch River, I would be horrified that we would fall even further behind the other countries. The measure of a nation's status in the breeder is where you are on the demonstration line.

And, as you know, in the early 1970's, France, the United Kingdom, and the Russians all demonstrated at that time the intermediate size breeder. Our demonstration, the Clinch River Reactor, is woefully behind schedule in that regard. So that is the way I measure the status of the U.S. program versus the other programs. We are well-endowed with basic technology.

Mrs. BOUQUARD. We are behind in our schedule but not in our basic technology.

Dr. BREWER. Yes.

Mrs. BOUQUARD. I was interested in the rationale used by the administration in determining what elements of the breeder base program are really the Government's responsibility and which should be allocated to the private sector.

Dr. BREWER. Would you like to address that, Mr. Chipman?

Mr. CHIPMAN. Madam Chairman, if you look closely at the budget that was submitted, you will find that the private sector involvement in the breeder base technology program has slightly increased on a percentage basis. Of course, everyone received a rather substantial cut. This does not mean that they in fact have an increased share of the budget.

However, it is, I believe, the administration's view and certainly the view of the nuclear energy group in the Department of Energy that one of the main objectives of our program is, in addition to developing the basic technology information, to see to it that the capability exists within the private sector to utilize this. And where possible, we are identifying areas where the private sector is in a position to better use the information we have—to actually take it and put it to use, to build something, to fabricate a component, to carry forth. One example that I might give you is that historically the Department's laboratories have focused in the safety arena in developing computer codes that are very important in breeder technology.

In the consolidation and reorientation of the program that we have just gone through, most of that has now been shifted to the private sector because we believe it is appropriate for them to deal with it.

We are continuing within the guidelines and the bounds of the budget that were submitted to the Congress. We are continuing to look to see where else we can appropriately transfer functions to the private sector.

Mrs. **Bouquard**. That is very good. The next question I am going to ask may seem rather redundant to you, but it is an issue that has been kicked around ever since I have been up here. And that is I would like you to elaborate again today on the potential of using nuclear energy in the future in place of oil.

Do you want that one, Gordon?

Mr. **Chipman**. Surely. That, of course, as you know, is a really high interest issue and I think one that is often debated on both sides. One of the things we need to first of all look at is how much of the electricity that we currently use is generated from oil. And it turns out that that quantity is about 1 million barrels of oil a day. That is equivalent to the imports from Saudi Arabia as a measure of the worth of that oil. It is also equivalent to about 6 percent of our total oil usage in this country. Clearly, coal and nuclear power could be utilized to substitute for most of that oil use.

In addition to that, most of the studies that I am aware of suggest that the displacement of petroleum products by electricity will grow with time. For example, we know that if we look at the projections for electric growth, electricity is going to increase its percentage of the available energy in this country. It is currently around 30 percent. By the year 2000 we are anticipating anywhere from 40 to 50 percent of the energy we use will be used for generating electricity.

Clearly that increased use will be accomplished instead of using oil in that area of the energy growth.

If you look at the left two columns in that slide, you see these are expressed in quads, current use of electricity for those three sectors of the economy. The second column shows the use projected by the Energy Information Agency for the year 2000. You see a significant increase.

Now, while it is almost impossible to quantify clearly some of that increase in electricity use, if electricity is not increased, it would have to be made up by oil. So that represents a rather substantial oil displacement in future growth.

If you then look at the next column, this represents an estimate, a reasonable estimate, of how much additional electric substitution would be possible in these sectors of the economy.

In the first number, the 1.8 quads, we believe that by adding more heat pumps to existing homes than was assumed in the

Energy Information Agency study, and assuming that 25 percent more of the new homes that were built had heat pumps, that you would in fact gain that much additional displacement of oil by electricity.

The 0.6 number in the industrial area is an estimate based on the fact that industry is more and more using electricity for any number of things, electroplating, microwave heating, radiofrequency heating. It is a reasonable extrapolation of the trends that we see today.

And in the transportation arena, of course, we know that Europe has been working very hard to electrify its public transportation such as trains and other smaller modes of transportation such as buses. And also the potential for the electric vehicle is very strong.

Now, I am not trying to suggest to you that these are absolutes, but they do represent a rather significant increase in the potential displacement of oil by electricity.

If you look at the last column to the right, that represents the million barrels of oil per day equivalent of that increased electric substitution from the third column. In other words, we think it is very reasonable that by the year 2000, in addition to the displacement that is already projected simply on the basis of business as usual, that we in fact can displace 4.3 million barrels of oil per day that would have otherwise had to be used.

Then to put that number in perspective, that is 80 percent of the 1981 oil imports and 200 percent of the imports projected for the year 2000. We in fact project a significfant reduction in oil imports with time. So that the amount of saving, potential saving in the electric arena alone would more than eliminate the need for oil imports.

I would make one last comment, and that is that the 1 million barrels of oil per day that is currently used to generate electricity is mostly residual oil that is imported from foreign countries.

Mrs. BOUQUARD. Thank you very much, Gordon. I have further questions, but I think we will defer to other members.

Mr. Wolpe?

Mr. WOLPE. Thank you, Madam Chairman. I know that she must share with me the reluctance at resuming what has been a long and very painful kind of dialog on this issue.

It was the judgment of the full Science and Technology Committee last year under close vote that the breeder reactor, the Clinch River breeder reactor, was not worthy of authorization.

Thanks very largely to the tremendously effective advocacy on the part of the chairman of this committee, that decision was reversed on the House floor.

Mrs. BOUQUARD. Would the gentleman yield? I remind him that we lost by one vote.

Mr. WOLPE. In committee, that is right. And you won by a somewhat larger margin on the House floor.

Mrs. BOUQUARD. The gentleman is correct.

Mr. WOLPE. I am acknowledging your adroitness in that effort. But I would argue that if the arguments in favor of deauthorization of the Clinch River breeder reactor were valid last term, they are even more valid with a vengeance, if you will, this term. Because the issue is no longer whether or not an investment in *x*, *y*, or *z* technology is desirable. In many respects we all wish we could do a little bit of everything. The issue that is being presented to this committee in a form in which it was not presented even last year is the necessity of making some very, very difficult choices. And the question really is where can we best invest increasingly scarce Federal resources and dollars in a way that will be most likely to quickly displace our dependence upon petroleum and at the lowest possible cost?

So with respect to the analysis of Mr. Chipman just now, it is really beside the point. The issue is not whether or not there would be some displacement of petroleum, and I want to get into that in a moment to clarify your own analysis, because I think in some respects it is a bit misleading, but that is not the issue. The issue is whether the dollars we are investing in Clinch River or would invest in the Clinch River breeder technology might be more efficiently invested in other activities of the Department of Energy that would have a much more beneficial impact, and a much more—upon the energy crisis, long-term and short-term, that we are facing in this county.

I would like to now move to a discussion of some of the economics that are really involved in making that kind of assessment. Let me begin just as a taking off point with the analysis of oil displacement. My understanding, so we have a common understanding as to the language that we are employing here, is that it is helpful, is it not, to distinguish between end-use consumption of energy on the one hand and primary energy on the other? And when you talk about a projection of 40 to 50 percent of our energy being addressed by one form or another into electricity in the year 2000 or thereabouts, you have, as I understand it, built into that statement not only your end-use consumption data, but also your conversion losses. Is that not accurate?

Mr. CHIPMAN. That is true, but that is true of any of the resources that I would compare it with.

Mr. WOLPE. Just so we understand precisely what we are talking about. And that, indeed, if you take just simply end-use consumption data, we are talking under the numbers that were generated by the Department of Energy and, as you know, there is some criticism of those numbers, but if we just begin with those numbers, they were talking about an end-use consumption figure somewhere in the area of 12 percent of all of our energy requirements being met by electricity in the year 2000. Is that not accurate?

Mr. CHIPMAN. I would say that the number as stated is correct. But it is very misleading because it doesn't matter how you use it. You have to come up with the energy input into the system. And that is right now 30 percent.

Mr. WOLPE. I just wanted us to at least understand that so we are at least not comparing apples and oranges when we use these numbers.

What is the current price of uranium?

Mr. CHIPMAN. The current contract price is about $31 a pound.

Mr. WOLPE. And what are the projections for uranium pricing, let's say, 10 years from now or by the year 2000?

Dr. BREWER. I will be happy to supply it for the record, Mr. Wolpe. I don't have it at this time.

[The information follows:]

Our projection of future prices of uranium concentrate, delivered under long-term contracts in year-of-delivery dollars is: 1982, $38; 1983, $43; 1984, $47; 1985, $52; 1986, $56; 1987, $61; 1988, $68; 1989, $75; and 1990, $86.

Mr. WOLPE. Do you have even a ballpark figure, even though we will not take it as an accurate figure?

Dr. BREWER. I would expect it could go as high as $100 or $120 a pound by the end of the century.

Mr. WOLPE. OK.

Mr. CHIPMAN. One fact of interest in that area is that in 1973 I believe the price of uranium was $7 a pound. And in spite of the downturn in the cost increase in the last few years, it has continued to rise. It is now $31 a pound after about 8 or 9 years.

Mr. WOLPE. OK. Are you comfortable, though, with the ballpark estimate of roughly $120, $130, somewhere in that range?

Dr. BREWER. Something like that. I think I would expect that that is a fair estimate, although I think our pencils are not sharp enough to——

Mr. WOLPE. I understand.

Dr. BREWER [continuing]. Plot that with any accuracy. Therefore, there is great uncertainty in all of these figures.

Mr. WOLPE. I certainly understand that. The projections that you have reached within the Department of Energy, what is the assumption with respect to low growth demand increases that those forecasts are based upon?

Mr. CHIPMAN. Which forecast is that?

Mr. WOLPE. Price forecast of uranium.

Mr. CHIPMAN. I think we are just speaking at this point of broad estimates. If you are looking for a specific price of uranium given a certain set of scenario inputs, that can be provided. It has been done a number of times a number of different ways.

Mr. WOLPE. What do you think is a reasonable projection independent of the uranium question for electricity demand annual rates of increase over the next couple of decades?

Dr. BREWER. I believe the current projection, done by my office—and it is a projection, not a requirement—is something like 200 gigawatts in the year 2000.

Mr. WOLPE. Could you translate that into percentage terms in terms of the rate of growth that you would anticipate, annual growth rate?

Mr. CHIPMAN. The annual growth rate that is projected by a large number of studies varies between 2 and 3 percent per year. The Department of Energy is currently projecting around 3 percent a year.

Mr. WOLPE. Let me at this point, then, make reference to two studies that perhaps you haven't yet had an opportunity to review. One is the product of the hearings on energy demand forecasting and its appropriate role in planning and policy, which were held under the chairmanship of Mr. Gore. And the conclusion that was reached on the basis of some very careful analysis of a variety of studies and hearing from a variety of experts was that growth in America's energy requirements including electricity will be much less dramatic than previously expected, reflecting tremendous improvements primarily in energy efficiency. Particularly with respect to electricity requirements, the conclusion reached was that the growth in electricity requirements would probably be at a rate well below 2 percent per year.

They went on to conclude that the overall efficiency with which energy is used by our society could increase by as much as 50 percent by the year 2000.

Now, I would like to take that set of findings over and against a study that was recently produced by the Los Alamos Laboratories, by Dr. Hardy and Dr. Thayer, entitled "Analysis of Nuclear Power Economics." And you will find within that study the following statement: "The results of liquid metal fast breeder reactor economics calculations shown in the previous figure were that the LMFBR fuel cycle system is more expensive than the pressurized water reactor once through system when uranium 232 is less than—sorry—238 is less than $165 a pound."

Now, I put that in the context of the present price of uranium being $30 and some odd cents that you had indicated earlier and against your own ballpark projections of, by the year 2000, maybe it will be at a $125, $135 per pound figure.

And that really leads against the fundamental question as to whether the project as it is contemplated can be economically justified at the time of severe restraint or whether we might not better find other kinds of investments that will yield a much better payback essentially.

Dr. **Brewer**. Mr. Wolpe, first of all, I am familiar with the Los Alamos report. I disagree with it. Our crossover analysis shows a crossover point of between $100 and $125.

The other thing I would like to say, even with a far lower than historic electrical growth rate, which is around 6 or 7 percent, let us assume 2 or 3 percent, even with 2 or 3 percent electrical growth, the total capacity of the entire system will have to double in something like 20 or 25 years.

Our current capacity is somewhere in the neighborhood of 600 gigawatts. That means that, disregarding retirements of plants, another 600 gigawatts will have to be ordered and placed on line in the next 25 or 30 years—600 gigawatts of something.

Mr. **Wolpe**. Let me just respond to that by making one other general observation analytically, and that is the problem of feedback as it enters into all of these analyses.

I have no question that if we pursue the present policy mix that this administration has offered up, which is the virtually total gutting of all of the energy-efficient, renewable energy technologies, both in the R. & D. and commercialization activities of this Government, and if we continue to pursue, as this administration has recommended, continued high subsidies to high technology industries, synthetic fuels and particularly nuclear power, that indeed the upper end of those projections will be accomplished. And we will find that because we will not have invested in policies and in technologies that can create a more efficient energy utilization that we will indeed be generating more electricity than we need or than is economic down the road.

The question is really whether or not we can, in terms of our policy direction, attempt to keep down the cost to the taxpayer and the cost to the energy consumer in the way we make our energy technology decisions. And I fear that we are simply creating our own self-fulfilling prophecy if we pursue the course that is reflected in the budget that is before this committee.

Dr. **Brewer**. Mr. Wolpe, I certainly won't argue with the belief that conservation and increasing efficiency of energy systems is a goal to be pursued.

I do feel, however, that it is not an ultimate solution. At some point one has to find and generate new energy.

I would like to just return to my arithmetic, if I may. I said we would need another 600 gigawatts. Let us suppose that half of that is fossil and the other half is nuclear, or half is coal and the other half is nuclear. That is another 250 gigawatts or 300 gigawatts of nuclear capacity, which is needed in the next 20 or 30 years.

Mr. **Wolpe**. Would the chairman indulge me——

Dr. **Brewer**. Even with the very low growth rate——

Mr. **Wolpe**. I am sorry. I did not mean to interrupt.

Would the chairman indulge me two very brief questions? I heard the little buzzer go off.

Mrs. **Bouquard**. Please proceed. We can come back before the question. I don't think there is any great hurry today, is there?

Mr. **Wolpe**. My problem is another commitment.

Mrs. **Bouquard**. Go ahead.

Mr. **Wolpe**. It will be very brief. Do you have plans to resubmit the application for a license exemption for the CRBR to the Nuclear Regulatory Commission?

Dr. **Brewer**. We are, of course, very disappointed in the Commission's decision last week. We are currently reevaluating our options. I still would like very much to accelerate the front end of the Clinch River schedule by as much as 18 months. We have not reached a decision within the department on our direct legal or licensing route at this time.

Mr. **Wolpe**. I hope you would reconsider that. I think it makes sense that the CRBR be licensed like all other nuclear facilities.

Dr. **Brewer**. Mr. Wolpe, I must correct you. We were not applying to delicense Clinch River.

Mr. **Wolpe**. I understand that. Dr. Brewer, what do you anticipate the level of Federal outlays to be away from reactor storage as represented on your chart?

Dr. **Brewer**. We have no plans for federalizing away from reactor fuel storage. We feel that it should be a commercial endeavor. That is a very small fraction of the total investment in nuclear power, which is over $130 billion on the private side.

Mr. **Wolpe**. Fine. Finally, to Mr. Chipman, TVA, as you know, recently canceled the construction of a nuclear plant due to a lack of demand. Don't you really think that the fact that the CRBR could provide electricity for 200 homes is a good reason to build—

Mrs. **Bouquard**. Would the gentleman yield?

Mr. **Wolpe**. I would be pleased to yield to the chair.

Mrs. **Bouquard**. We have deferred construction but we are proceeding with the construction of two or three new plants, but they were not canceled. It was strictly a deferral.

Mr. **Wolpe**. Because of the lack of demand, is that not correct?

Mr. **Chipman**. No one suggested that this electric use is the reason for Clinch River. It is, however, a side benefit. And if that were the only reason for building Clinch River, you would have to make the choice between burning coal or burning oil or having Clinch River.

Mr. **Wolpe**. Thank you very much.

Thank you for your indulgence, Madam Chairman.

Mrs. **Bouquard**. Thank you, Mr Wolpe.

Mr. Lowery.

Mr. **Lowery**. Thank you, Madam Chairman.

Secretary Brewer, we are happy to have you here. With the development of Phenix and Super Phenix breeder reactors, it appears that France has emerged as the leader in the development of breeder technology. Mr. Brewer, why have we fallen behind in the United States and how will the program that you have outlined regain a U.S. position of leadership?

Dr. **Brewer**. I will give my personal opinion on why we have fallen behind, Mr. Lowery. When we launched the breeder program back in the 1950's and 1960's, there was not a clear focused schedule. The emphasis in the program was on base technology development and fuels and physics rather than a progression of actual projects. You can't get there without building plants and scaling them up to sizes of commercial interest.

Now, the other countries, such as France, set about very deliberately with Rhapsody, with Phenix and then Super Phenix. That was their driving force. And the rest of the program was driven by that schedule

So our program was base technology oriented. The French program was project and deliverable oriented.

Another reason, of course, is that France needs the breeder in a timeframe much earlier than we do.

Mr. **Lowery**. And how is the current program which you have outlined going to regain a position of leadership for the United States?

Dr. **Brewer**. The President's emphasis on expedition of the Clinch River schedule as the next step in plant scale-up will regain, our schedule. It will not catch up with the French in the sense of Super Phenix. The Clinch River design, I might add, although it is a 350-megawatt plant compared to the Super Phenix of 1,200 megawatts, has the most current technology in fuels and in core design and steam generator design and the design of the heat transport system.

Mr. **Lowery**. It sounds like you have anticipated my next question, and that is on the design of CRBR, which has been criticized as a, "technological turkey." Your comments are that it incorporates the most advanced technologies in these areas.

Dr. **Brewer**. In my judgment, Mr. Lowery, it is not a technological turkey. I would like to have had it on line as originally scheduled in 1983, but the legacy of the past 5 years has slipped us more than a day for a day. And our mission now is to catch up.

Mr. **Lowery**. Do you believe any major changes are needed in design?

Dr. **Brewer**. In the design of Clinch River?

Mr. **Lowery**. Right.

Dr. **Brewer**. No, sir.

Mr. **Lowery**. I understand that Walter Marshall, the head of the British breeder program, believes that their breeder would be economically competitive with oil-fired generation. What do you see as the economics of our program compared with the alternatives?

Dr. **Brewer**. It, of course, depends on the price of the alternative fuel forms, but one major attribute of the breeder is that it caps the cost, totally insulates the cost, of nuclear fuel and other alternatives from inflation. Its fuel cycle costs are negligible. It does not require mining, at least for the next several centuries, of uranium. You can go to very low grade ores. The fuel cycle component, the operating component of cost is negligibe. That has a tendency to, once you have the plant built, insulate that plant from inflationary pressures and, in fact, has a tendency to draw the other fuels down to its level.

Mr. **Lowery**. It has been contended that CRBR is not necessary, that we can bypass it and go right to, as President Carter said, "a bigger and better reactor." Would you comment on that statement?

Dr. **Brewer**. Well, it is a judgment on how much scale-up risk you want to take between the FFTF size of plant and the 1000-megawatt breeder. I think the scale-up from FFTF size components to Clinch River, which is about a factor of 3, is a prudent risk. I think we should finish what we have started. To think of a better idea now because it has more romance is not a prudent policy.

Mr. **Lowery**. Do we really need to go ahead with the base breeder program while we are working on CRBR?

Dr. **Brewer**. Yes, sir, I think the breeder-base technology program should be trimmed down somewhat and made more relevant to the future course and schedule of the breeder program. It should be tied very closely to the requirements of Clinch River and whatever comes beyond Clinch River. We should put more emphasis on breeder fuel reprocessing, perhaps a little less in some of the other areas.

Mr. **Lowery**. Wouldn't it be more economical to await the results of CRBR before we proceed further? Is that in essence what you are saying?

Dr. **Brewer**. No, sir. It is my judgment that we need or should have the capability to reprocess breeder fuel soon after we have Clinch River and perhaps a follow-on plant on line. Otherwise the plutonium requirements for the total program just become exhorbitant.

Mr. **Lowery**. A final question on the breeder and then I want to ask a couple of questions on HTGR. Mr. Wolpe mentioned the Los Alamos study on breeder economics. The study was based on a computer model that I understand is rather simply constructed and that does not take into account changes over time.

Could you comment? Is it true that the model can be and has been used to show that almost any new energy technology is not economic, including ocean thermal, solar, geothermal, and the like?

Dr. **Brewer**. I am not aware of that conclusion, Mr. Lowery, but it sounds reasonable.

Mr. **Lowery**. Do you like it?

Dr. **Brewer**. Yes, I like it.

Mr. LOWERY. And I think that probably could be true because of the heavy costs involved in a lot of the R. & D., such as capital costs, startup costs and the like.

Dr. BREWER. Yes, sir.

Mr. CHIPMAN. If I might add to that, Mr. Lowery——

Mr. LOWERY. Please.

Mr. CHIPMAN. The cost of the breeder in terms of electricity from the breeder in the future, when that becomes economic, is going to depend on the increase in the cost of other fuels, and that is very hard to predict. Just as a point of comparison, research on the breeder and photovoltaics began in the early 1950's. Today to buy a photovoltaic array—not to install it, not to add the power manipulating equipment, not to add any storage equipment—is 10 times the cost of a nuclear power plant that is going on line today. That does not suggest we should not work on photovoltaics.

And the same kind of argument should be applied here. Just because things are a little expensive today doesn't mean we won't need them in the future.

Mr. LOWERY. But the key argument as far as breeders are concerned is does it really tend to pull down the cost of the nuclear fuel simply because we can continue to make it in the breeder.

Moving over to HTGR, Dr. Brewer, why does the administration insist on continuing the zero funds for the high-temperature, gas-cooled program when it is obvious that there is great support for it both in this committee and in the Congress as a whole?

Dr. BREWER. Mr. Lowery, the administration supports the HTGR for applications which are unique to helium. Those are applications which water and liquid metal cannot reach. The language of last year's Omnibus Budget Reconciliation Act, I believe in August, included language that said that fiscal year 1982 was the last year for funding of the HTGR unless the private sector came forward with a definable and meaningful cost-sharing proposal.

In spite of our best efforts to draw this proposal forward, it has not arrived yet. If such a proposal or letter of intent arrives before the beginning of fiscal year 1983, the department will consider resubmitting a budget item for the HTGR.

Mr. LOWERY. What was the original fiscal year 1983 budget request? And by original, I mean before it was sent to OMB. I guess that could be spelled BOMB or bomb. But what was the original DOE request for the fiscal year 1983 budget for HTGR?

Dr. BREWER. It was $40 million.

Mr. LOWERY. And following that, can you provide the Holifield tables covering each HTGR?

Dr. BREWER. Yes, I will. It was $40 million plus the fuel cycle, which was about $3 million. So I would say a total of $43 million for the HTGR was our request to OMB.

Mr. LOWERY. And where did those funds get shifted that you requested?

Dr. BREWER. Well, it is terribly difficult to say, Mr. Lowery.

Mr. LOWERY. We need a good auditor.

Dr. BREWER. All over.

Mr. LOWERY. Any particular areas where most of those funds showed up?

Dr. BREWER. No, sir. There was a general reduction from our overall request.

Mr. LOWERY. This has been zeroed out completely?

Dr. BREWER. Yes.

Mr. LOWERY. Thank you.

Madam Chairman, thank you very much.

Mrs. BOUQUARD. Thank you, Mr. Lowery.

Mr. Volkmer?

Mr. VOLKMER. Thank you, Madam Chairman. I have several questions.

I notice from reading the testimony, I am sure I wasn't here, that our colleague from Washington State objects a little bit to the reduction in the funding on FFTF, fast flux. You feel that that funding isn't necessary; is that correct?

Dr. BREWER. Mr. Volkmer, I would not say it is not necessary. I would say with a reduction in the breeder base program of over $100 million, it was unavoidable. Now, we are talking about a reduction of $100 million to a total of about $270 million in base operating. If FMEF and FFTF were to continue on its perceived funding plan for fiscal year 1983, that would mean that we would be spending two-thirds of the total breeder base technology funding at one site on one program element of the breeder program, two-thirds on fuels research. We felt that this was not prudent, that it did not reflect the proper balance across the breeder program and, accordingly, we stretched out FMEF.

Mr. VOLKMER. And you don't feel that that is going to do away with the programs there in Hanford?

Dr. BREWER. No, sir. The program is——

Mr. VOLKMER. Still continuing?

Dr. BREWER. The FFTF will continue to run and the——

Mr. VOLKMER. They will make the test, maybe a little later, but they will be able to make a few tests?

Dr. BREWER. Later or at another site——

Mr. VOLKMER. Right.

Dr. BREWER [continuing]. That exists now.

Mr. CHIPMAN. Mr. Volkmer, one of the factors involved in the FFTF reduction was the fact that this plant is now coming on line as a full operating test facility. And in the past it had a large number of staff that were there to support the safety analysis to get this facility built and operating. So there is a natural transition and reduction involved here. In addition to that, we had to reduce because of the budget constraints.

Mr. VOLKMER. All right. What is the update on estimated construction costs now on Clinch River? What are we up to now?

Mr. CHIPMAN. We are in the process of taking a very close look at that issue at this moment, sir.

Mr. VOLKMER. Would you advise the committee as soon as possible in writing?

Mr. CHIPMAN. We certainly will.

Mr. VOLKMER. What you estimate the total cost will be now?

Mr. CHIPMAN. Yes, sir.

Dr. BREWER. Yes.

Mr. VOLKMER. And what would you consider to be the minimum baseline that would be necessary in order to continue the Clinch River project?

Dr. BREWER. The fiscal year 1983 request is $252.5 million. With our accelerated schedule, the $252.5 million is somewhat insufficient itself. Therefore, we are pressing very hard to have the utility contributions accelerated into fiscal year 1983 to pick up the gap; $252.5 million is absolutely rock bottom necessary to maintain the accelerated schedule.

Mr. VOLKMER. What if you dropped the accelerated schedule?

Mr. CHIPMAN. Mr. Volkmer, the project has already experienced a 5-year delay because of what we call——

Mr. VOLKMER. I know what it is.

Mr. CHIPMAN [continuing]. The policy debate.

Mr. VOLKMER. You are not telling me anything.

Mr. CHIPMAN. I understand. But I want to put into perspective what a reduced funding will do.

Mr. VOLKMER. Fine.

Mr. CHIPMAN. If we want to continue to stretch out in this project by additional years, then reduced funding is possible.

Mr. VOLKMER. OK. How much reduced?

Mr. CHIPMAN. I guess——

Mr. VOLKMER. $50 million, $60 million?

Mr. CHIPMAN. I guess theoretically you could reduce it to almost any level.

Mr. VOLKMER. Well, you have to have some. I mean, I notice here that you are pretty far along on it, the way I understand it. Maybe I am wrong, where 96 percent research and development, 87 percent engineering, 60 percent equipment procurement. That is where we were January 1. So we are not way, you know, way far away, are we?

Mr. CHIPMAN. We are way far away in actual construction.

Mr. VOLKMER. Yes.

Mr. CHIPMAN. We have not dug a hole——

Mr. VOLKMER. Right.

Mr. CHIPMAN [continuing]. And laid concrete.

Mr. VOLKMER. The engineering won't change that much. The research and development that has been done, and that won't change that much.

Mr. CHIPMAN. You have the problem that as you continue to stretch out the project, what you incur is a gross inefficiency. And every year that you are not doing what you could do with reasonable funding, you are carrying a rather substantial staff that really can't be let go. If we continue to delay the project, we will eventually complete design work, we will eventually complete all components, these can eventually be stored, then you will have storage fees. You will either have to decide you are going to let all the engineers go and then retrain them when you hire them back to figure out how to put those components together, or you pay to keep them on. It is extremely inefficent.

Dr. BREWER. Mr. Volkmer, I would like to try for the record to answer your question in a quantitative fashion. A certain cut corresponds to a certain schedule slippage. And we will provide that for the record.

[The information follows:]

REDUCTION IN FISCAL YEAR 1983 CRBRP FUNDING

The requested budget of $252.5 million will permit the conduct of site preparation activities beginning in April 1983. This would lead to achieving plant criticality in September 1989.

A reduction in fiscal year 1983 budget authority of $60 million, from $252.5 million to $192.5 million, would delay the start of site preparation activities from April 1983 to October 1983. Initial criticality would also slip by 6 months to March 1990. The full research and development benefits which will accrue from this project would therefore be delayed once again. Such a funding reduction with its associated schedule slippage would increase total project costs by approximately $100 million.

Mr. **VOLKMER**. OK. I would appreciate that.

All right. Now, you mentioned you have placed emphasis—and as soon as my time is up, I will quit, and we will go back and start over again.

Mrs. **BOUQUARD**. Go right ahead.

Mr. **VOLKMER**. You have placed emphasis on breeder fuel reprocessing at this time, I believe you made statements similar to that effect.

Dr. **BREWER**. Yes, sir. I think we have to put more priority to that area.

Mr. **VOLKMER**. Where?

Dr. **BREWER**. Where?

Mr. **VOLKMER**. Where.

Dr. **BREWER**. The research and development work is being conducted at Oak Ridge National Laboratory. We have finished the integrated engineering test facility, which is a cold test line for testing shears and dissolvers and the process equipment for breeder reprocessing.

Mr. **VOLKMER**. Right. I have seen that. Go ahead.

Dr. **BREWER**. The next step beyond that is a facility which we have on the drawing board called the hot experimental facility, which is a pilot or a demonstration reprocessing plant, and that has not been sited.

Mr. **VOLKMER**. So we are not talking about Barnwell, then?

Dr. **BREWER**. Location at Barnwell is a possibility.

Mr. **VOLKMER**. We still have, I believe, $10 million in here to continue through Allied, continue work at Barnwell; is that correct?

Dr. **BREWER**. Yes, sir. $10 million for safeguards R. & D. at Barnwell.

Mr. **VOLKMER**. Yes. All right. The enrichment plant at Portsmouth?

Dr. **BREWER**. Yes, sir.

Mr. **VOLKMER**. Construction costs are included in the total that is in here that is shown on the uranium enrichment?

Dr. **BREWER**. Yes, sir. It is offset, however, by——

Mr. **VOLKMER**. No, I mean that is included in the total enrichment budget that is here.

Dr. **BREWER**. Yes, sir.

Mr. **VOLKMER**. I believe it was, and that is offset by the revenues that were received.

Dr. **BREWER**. Yes, sir, it is offset by the revenues.

Mr. **VOLKMER**. I mean, that includes the finished construction costs at Portsmouth.

Dr. **Brewer**. Yes, sir, it does.

Mr. **Volkmer**. All right.

Dr. **Brewer**. There is a point I would like to clarify, and that is that the revenues are about $2 billion in fiscal year 1983 and the costs are about $2 billion in fiscal year 1983, netting out to about zero. However, in calculating the price of the separative work units [SWU], we cannot put construction costs in the rate base until the thing goes operational.

Mr. **Volkmer**. I understand what you are saying. You are saying that the recovery of the construction costs at Portsmouth will not be included in the enrichment fees that are presently being charged until it goes operational?

Dr. **Brewer**. Yes, sir.

Mr. **Volkmer**. But the revenues that presently exist that are coming in are sufficient to offset not only the expense of enrichment at the other places but also the construction at Portsmouth?

Dr. **Brewer**. Exactly.

Mr. **Volkmer**. In other words, we don't have to put any more money in enrichment this year?

Dr. **Brewer**. No, sir. In fact, there is a carryover of about $60 million in projected excess revenues in fiscal year 1983.

Mr. **Volkmer**. Yes. Can I continue or do you want me to quit and you start? I still have one area to cover.

Mrs. **Bouquard**. You still have the time, Mr. Volkmer.

Mr. **Volkmer**. OK. The other area that I would like to cover is waste disposal.

Dr. **Brewer**. Yes, sir.

Mr. **Volkmer**. And the time table that you may have or may not have for any repository.

Dr. **Brewer**. Yes, sir. Dr. Coffman?

Dr. **Coffman**. Thank you. The program that we are pursuing at present is aimed at initiating exploratory shaft work during the next calendar year of 1983, to complete that shaft work in 1985 and to proceed with siting and license application decisions.

To allow us to make a siting decision and a license application as soon after 1985 as possible, the base line schedule that has been publicized in the plan talks about a 1988 license application and a 4-year NRC license review process which would result in a repository operation in the 1998 timeframe.

Through the pending legislation before this committee as well as other committees of the House and Senate, we are seeking an expedited licensing process and an expedited siting process, which we estimate could have a repository operational before 1995.

Mr. **Volkmer**. Now, there is a proposal to establish a $185-million fund, right?

Dr. **Coffman**. Yes.

Mr. **Volkmer**. Which we haven't seen yet, but legislation has been sent here; is that correct?

Dr. **Coffman**. The administration has not proposed legislation on this because, again, the House Science and Technology Committee and committees in the Senate have bills reported out or in markup which address this. And we are playing a supportive and comment role through the House and Senate action on this.

The plan, though, is in fiscal 1983 for there to be provided $185 million of borrowing authority and fee collection from the utilities. For the generic R. & D., the appropriated monies is $50 million of fiscal 1983.

Mr. **Volkmer**. All right. Now, once you start accumulating the money, what is going to happen to it and when?

Dr. **Coffman**. The basic proposal is to collect revenues into a special fund including borrowing authority to take the humps out of major construction projects. And it is estimated that the 1 mill per kilowatt hour or equivalent contracting requirement with the utilities, would be fully adequate to cover the project's specific R. & D. operations and construction costs.

In the event that we are overcollecting or undercollecting, the mill per kilowatt hour would be revised up or down to give you full cost reimbursement.

Mr. **Volkmer**. What are you using the money for?

Dr. **Coffman**. I am sorry?

Mr. **Volkmer**. I know you are collecting the money. Where are you using it?

Dr. **Coffman**. The money, for example, in fiscal 1982——

Mr. **Volkmer**. You have got a revolving fund here. I don't care whether it is 1983, 1984, or 1985. What are you using it for?

Dr. **Coffman**. The monies from this fund would pay for the contractor work being conducted at Hanford, Nevada, and in the salt programs, the construction of the shafts, the collection of the hydrologic data, the license application, the NEPA document, all of the R. & D. construction all the way to the point of taking waste.

Mr. **Volkmer**. One last question and I will quit for now and then go back again. The last question basically is the 1 mill OK? Now, that is to be authorized to be collected by the utilities, right?

Dr. **Coffman**. That is authorized to be collected from the utilities. It would be mandated legislation. That would be collected, perhaps, by the Department and banked in the U.S. Treasury and then dispersed as in other special funds, very similar to the uranium enrichment.

Mr. **Volkmer**. I don't have any further questions right now.

Mrs. **Bouquard**. Thank you very much, Mr. Volkmer. I just have a couple more questions. Getting back to Mr. Morrison's testimony, is it really prudent to descope our FMEF activities in light of the substantial investment that we have made in these facilities? I am very concerned about the long-term impact of this decision, Dr. Brewer.

Dr. **Brewer**. Ms. Bouquard, our intent is to finish the building and the structure that will house the SAF line and to delay the SAF line for some time. The SAF line is the high-speed fuel fabrication facility.

The element of FMEF for which we have no current plans to complete is the examination equipment, the equipment that you would use to examine the fuel coming out of FFTF. That function can be performed for the time being in several other facilities at Hanford, in Idaho, and at Los Alamos.

I think it is prudent to take the cut in that area.

Mrs. **Bouquard**. Will this be a short-term decision in your opinion?

Dr. **Brewer.** There may come a time in the future at which we may install examination equipment in FMEF. We certainly plan to go forward with the fabrication demonstration, the SAF line. What is up in the air at this time is the future of the examination cells at FMEF.

Mrs. **Bouquard.** There is one thing I was rather curious about. At what rate is electric power produced at EBR–II being sold?

Dr. **Brewer.** Mr. Chipman?

Mrs. **Bouquard.** Is this a commercial rate, Gordon?

Mr. **Chipman.** It is not a commercial rate at this time, Madame Chairman. The agreements dealing with the sale of power to them has been in existence for a long time. In the not too distant past we obtained a ruling that the EBR–II electric generation qualifies as a cogeneration facility, and under the PURPA (Public Utilities Regulatory Policies Act of 1978) rules is eligible for consideration of a much higher rate of return on its electric generation. That matter is currently being considered by the utility organization that we have an agreement with. So far we have not come to closure on that, but the issue is being pursued.

Mrs. **Bouquard.** Thank you very much.

Mr. Volkmer?

Mr. **Volkmer.** Yes; I would like to continue with one other question I had, just continue it.

The research and development on safety, et cetera, that is being done at Barnwell, that could be done later on, could it not, when we do, if ever, build the facility or continue on the progress for reprocessing?

Dr. **Brewer.** Mr. Laughon?

Mr. **Laughon.** Thank you. At the current time, Mr. Volkmer, the owners of the Barnwell facility have stated their intention to write the plant off their books at the end of the current year for tax purposes. We believe there is a valid charter to do government-sponsored R. & D. work at the Barnwell facility. It is the largest commercial type fuel reprocessing plant currently available in the world. So that the rationale for doing the work there has to do with benefits in terms of international safeguards, development, attempting to assist industry to see through, if you will, the uncertainties that they face in terms of licensing including safeguards concerns, should one or more private industrial organizations choose to try to operate the plant.

But to answer your question specifically, could it wait, it could not wait if the plant is shut down and abandoned.

Mr. **Volkmer.** What do you mean it couldn't wait if the plant is shut down and abandoned?

Mr. **Laughon.** Barnwell currently has a staff of approximately 315 personnel.

Mr. **Volkmer.** All right.

Mr. **Laughon.** A shutdown of the plant would disperse the personnel.

Mr. **Volkmer.** OK.

Mr. **Laughon.** And might render it inoperable or unable to be used for testing.

Mr. **Volkmer.** You mean even 2 years from now or 3 years from now or 4 years from now nobody could go back in there?

Mr. LAUGHON. As I understand it, the owners believe they might have to render it an inoperable plant for tax writeoff purposes.

Mr. VOLKMER. Well, so be it.

The other question I have, and maybe I can get it from the NRC, I asked the Secretary when he was here previously to provide information as to the number of light water reactors that are presently generating or in the same position, as I understand from newspaper accounts, as Vepco's Anna reactor is, as to spent rods storage on site. Maybe you can get it for me.

Dr. BREWER. I will certainly be happy to, Mr. Volkmer. I will give you a table which shows the——

Mr. VOLKMER. Storage capability?

Dr. BREWER [continuing]. Storage capability and the runout time for each plant in the country.

Mr. VOLKMER. I would appreciate that.

Dr. BREWER. Yes, sir.

[The information follows:]

The following presents the Department's preliminary estimates of the Nation's spent fuel storage requirements. These storage requirements represent the additional storage capacity that must be provided in order to enable continued reactor operation. A report of requirements will be available in the near future.

Utility	Year Additional Storage Capacity Is First Required* (Year)	Cumulative Additional Storage Capacity Required through 1992* (MTU)
1. Virginia Electric and Power	1985	280
2. Carolina Power and Light Company	1986	335
3. Consumers Power Company	1986	117
4. Florida Power and Light Company	1986	351
5. Philadelphia Electric Company	1987	366
6. Boston Edison Company	1988	105
7. Rochester Gas and Electric Company	1989	49
8. Duke Power Company	1989	223
9. Northeast Utilities	1989	96
10. Northern States Power Company	1989	94
11. Power Authority - State of New York	1989	177
12. Yankee Atomic Electric Company	1989	63
13. Southern California Edison Company	1990	113
14. Dairyland Power Cooperative	1990	10
15. Maine Yankee Atomic Power Company	1992	29
16. Baltimore Gas and Electric Company	1992	20
17. Commonwealth Edison Company	1992	13
18. Detroit Edison Company	1992	17
Total		2458

* Assumptions

(1) Pool capacities increased to the maximum.

(2) No transshipment except where licensed by the Nuclear Regulatory Commission.

(3) Onsite transfers as planned.

(4) Full core reserve capacity maintained.

Mrs. **Bouquard**. Thank you very much, Mr. Volkmer. Are there further questions? If not, I certainly would like to express the appreciation of this subcommittee for your very valuable testimony and the hard work you have put into your preparation for the hearings today. And certainly your preparation helps us in formulating the decisions and policy of the subcommittee.

Our next meeting will be tomorrow at 1 p.m., and the subject will again be breeder reactor and nuclear fuel cycle programs. We will hear from the industry panel as well as the Nuclear Regulatory Commission.

[Whereupon the hearing was recessed, to reconvene the following day at 1 p.m.]

FISCAL YEAR 1983 DEPARTMENT OF ENERGY BUDGET REVIEW

WEDNESDAY, MARCH 10, 1982

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met, pursuant to recess, at 1:05 p.m., in room 3518, Rayburn House Office Building, Hon. Marilyn L. Bouquard (chairman of the subcommittee) presiding.

Present: Representatives Bouquard, Wolpe, Volkmer, Lundine, Lowery, and Hollenbeck.

Staff present: Nelson Milder, staff consultant; Lou Ventre, counsel; and Lee Wallace, Republican energy director.

Mrs. **Bouquard**. The subcommittee will come to order. Good afternoon, ladies and gentlemen. Today we welcome a very distinguished panel of utility spokesmen for both private and public power, and two spokesmen for the major industry players in the Clinch River Breeder Reactor project. However, I would like to point out that just as we did in yesterday's hearing, our purpose is to discuss the overall liquid metal fast breeder reactor program, related reprocessing R. & D. activities, and the water cooled breeder reactor program. I expect that we will have a solid status report on the overall program from the industry perspective.

In addition, we have Mr. William Dircks, who is the Executive Director for Operations of the United States Nuclear Regulatory Commission. He will tell us about the status of NRC activities in support of the overall breeder program and reprocessing.

We will have a showing of a 10-minute film which is effectively a status report of major procurements for the Clinch River project, and I believe all the Members will find this very informative—all those that are here. We have made a change. We are going to show it right after Mr. Dubrow's testimony.

We certainly welcome our panel today consisting of Mr. Jack Kearney, senior vice president, Energy and Environmental Activities, Edison Electric Institute; Mr. Morgan Dubrow, senior staff engineer, National Rural Electric Cooperative Association; Dr. John Yasinsky, general manager, Advanced Power Systems Division, Westinghouse Electric Corp.; and Mr. Robert Richards, general manager, Advanced Reactor Systems Division, General Electric.

Welcome, gentlemen, to our subcommittee. Please proceed as you wish.

Mr. **Wolpe**. Madam Chairman?

Mrs. **Bouquard**. Mr. Wolpe?

Mr. **Wolpe**. Just by way of brief inquiry—I want to apologize in advance to the members of the panel and to you for my inability to sit through the entire hearing today. I have, however, reviewed the written testimony that was submitted, and I note that all of the witnesses of our very distinguished panel have a rather consistent point of view.

My question really is do we have a plan to have a panel of people who have raised critical questions with respect to the breeder program and the Clinch River issue in the days ahead? Is there another panel that is scheduled?

Mrs. **Bouquard**. To answer your question, Mr. Wolpe, I think the film explains the progress of the program. This is to review the status.

Mr. **Wolpe**. Yes.

Mrs. **Bouquard**. I think that is the focus of today's hearing. We feel that a lot of insight will also be put into this by hearing Mr. Dircks.

We publicized the fact that these hearings were to be held and the witnesses who wished to respond could do so. However, there will be no other hearing on Clinch River.

Mr. **Wolpe**. I think that is unfortunate because I think it would be useful in terms of balanced presentation before this committee if we were able to have a panel of people who raise critical questions as well as those who are advocates for the program. I think it would be useful for our committee's deliberations. I would at least ask if that decision might be thought through again.

Mrs. **Bouquard**. We will certainly take this under consideration, Mr. Wolpe.

Mr. **Wolpe**. Thank you very much.

Mrs. **Bouquard**. Please proceed, Mr. Kearney.

STATEMENT OF JOHN J. KEARNEY, SENIOR VICE PRESIDENT, ENERGY AND ENVIRONMENTAL ACTIVITIES, EDISON ELECTRIC INSTITUTE, ACCOMPANIED BY MORGAN DUBROW, SENIOR STAFF ENGINEER, NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION; JOHN YASINSKY, GENERAL MANAGER, ADVANCED POWER SYSTEMS DIVISION, WESTINGHOUSE ELECTRIC CORP.; AND ROBERT RICHARDS, GENERAL MANAGER, ADVANCED REACTOR SYSTEMS DIVISION, GENERAL ELECTRIC

Mr. **Kearney**. Madam Chairman and Mr. Wolpe, my name is John J. Kearney. I am a senior vice president of the Edison Institute which is the national association of investor-owned utility companies.

The institute members provide 78 percent of the Nation's electricity and serve approximately 68 million customers.

We, of course, are pleased to be here to present the institute's views on the fiscal 1983 civilian nuclear budget as it pertains to research and development.

We appreciate your initiative to maintain a dialog with the electric utility industry concerning these very important energy matters.

With your permission, I would like to have my full statement, with comments on several aspects of the DOE nuclear budget, submitted for the record. In the next few moments, I would just like to summarize our views on breeder reactor technology.

Mrs. **Bouquard**. Without objection, your complete statement will be made a part of the record, and all of you gentlemen may proceed as you wish.

Mr. **Kearney**. Thank you. Our industry continues, as has been documented on many occasions, to support the Clinch River breeder reactor which we firmly believe is the current focal point for the breeder reactor program.

I might point out to you that electric utilities are energy convertors; therefore, we have no vested interest in any particular fuel resource or conversion process. The objective of the industry is to provide electricity at the lowest practical cost on an environmentally acceptable basis in a dependable and reliable manner.

With this objective in mind, we have concluded that at this stage the conservative, high-confidence path necessary to assure electric power supply requirements is the early development of the liquid metal fast breeder reactor.

Numerous studies have been performed over the past two decades to evaluate the many nuclear options and to define preferred technology. Among the more recent studies have been the 66-nation international nuclear fuel evaluation program, the nonproliferation alternative system assessment program, and the study of the National Academy of Science Committee on nuclear and alternative energy systems. Each of these studies and their predecessors came to the conclusion that the LMFBR offers the best, long-term technology prospect for insuring an adequate lifetime fuel supply for the nuclear powerplants which will be needed in the next century.

LMFBR technology entails major challenges that require massive efforts, both in manpower resources and in development funds. Building upon the research and development efforts of the past 25 years, we are definitely at a point where a demonstration facility should be built and operated as soon as possible.

The 375-megawatt Clinch River breeder reactor is the right size to achieve prudent extrapolation from the FFTF technology. The research and the development necessary for the CRBR is 96 percent complete, and the engineering design is 85 percent complete.

Many of the major components have been fabricated, and equipment worth $610 million has already been received or is on order. Design improvements have been incorporated to reflect the most advanced state of art in LMFBR technology.

Costs, unfortunately, have increased. In fact, they have increased by $857 million due to delays. CRBR, therefore, in our judgment should be constructed on an expeditious schedule to minimize unnecessary further-delay costs.

We are pleased that the administration is supporting this goal, and with continued support from the Congress, the project is gaining momentum to move ahead.

Completion of CRBR is the next and currently most important step in assuring that our Nation has access to the LMFBR on a timely basis.

The electric utility industry has supported the Clinch River reactor since its conception. It entered into a cooperative agreement in 1971 with the Federal Government to support CRBR. A funding pledge of $250 million was provided from a combination of about 750 electric utility organizations, including investor-owned, public, and cooperative utilities.

This is the largest utility-industry commitment ever made to such a program.

Attached to our written statement is the 1981 annual report of the Project Management Corp. This provides a pictorial and written presentation including a brief chronology of the program objectives, its significant progress during 1981, and its current status.

With the continued support of Government, we believe that the next most important step in the breeder reactor development program—the building of the Clinch River breeder reactor—can be carried out successfully so that the American people will attain the benefits of the development of breeder technology.

Madam Chairman, thank you very much.

[The prepared statement of Mr. Kearney, plus the 1981 annual report mentioned above, follows:]

STATEMENT OF

MR. JOHN J. KEARNEY
SENIOR VICE PRESIDENT
EDISON ELECTRIC INSTITUTE

ON

FISCAL YEAR 1983 CIVILIAN NUCLEAR BUDGET REQUEST

Before the

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

COMMITTEE ON SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

March 10, 1982

Madam Chairman and Subcommittee Members, I am John J. Kearney, Senior Vice President of the Edison Electric Institute. The Institute is the association of investor-owned electric utilities. Its members provide about 78 percent of the nation's electricity, serving over 67 million customers.

I am pleased to appear before you today to present the Institute's views on the Fiscal Year 1983 Civilian Nuclear Budget as it pertains to nuclear research and development programs, in particular with respect to breeder reactors and nuclear fuel cycle reprocessing. We appreciate your initiative to maintain a continuing dialogue with the electric utility industry regarding these important energy matters.

Breeder Reactors

Our industry continues, as documented by the many times we have had the privilege to appear before your Committee, to support this nation's breeder reactor program. We are firmly convinced that breeder reactors must be developed as a long-term fuel resource for the production of electricity, and we believe that the LMFBR program is the preferred technology.

Electric utilities are energy converters and therefore do not have a vested interest in a particular fuel resource or conversion process. Their objective is in providing electricity at the lowest practical cost on a dependable and reliable basis, and in a safe and environmentally acceptable fashion. With this objective in mind, at this stage the conservative, high confidence path necessary to electric utility industry operations requires the early development of the LMFBR technology.

Nuclear power is recognized by all industrialized nations of the world as being a necessary energy resource. During both the Ottawa Economic Summit Conference in July 1981 and the Vienna Economic Summit Conference in June 1980, the need for greater use of nuclear power was recognized and accepted by all. During the World Energy Conference in September 1980 in Germany, the U.S. was roundly criticized for being badly out of step in the development of nuclear energy. The condemnation of the United States in the past by the foreign nations for holding back nuclear progress was not gratuitous. A number of developing countries as well as the more industrialized countries are rightly concerned with the prospects of competing with the U.S. for oil. They recognize full well the connection between oil and nuclear power. While our country has been waffling on nuclear, other nations such as Great Britain, France, Germany, Japan and the Soviet Union have been moving ahead swiftly, not only with conventional nuclear power plants, but also with breeder reactors.

Numerous studies have been performed over the past two decades to evaluate the many nuclear options and to define the preferred technology. The more recent major studies include the 66-nation International Nuclear Fuel Cycle Evaluation (INFCE), the Non-Proliferation Alternative Systems Assessment Program (NASAP) by the U.S. Government, and the study by the National Academy of Sciences Committee on Nuclear and Alternative Energy Systems (CONAES). Each of these studies, and those that preceded them, came to the conclusion that the LMFBR offers the best long-term technological prospect for insuring an adequate lifetime fuel supply for the nuclear power plants that will be needed in the next century. The LMFBR will extend this resource by a factor of about 60, and enable us to productively utilize the huge potential energy value of the abundant Uranium-238 isotope which is of little value in thermal reactors.

We fully recognize that the LMFBR technology entails major challenges that require massive efforts both in manpower resources and in developmental funding. Building upon the research and development efforts of the past 25 years, we are definitely at the point where a demonstration facility should be built and operated as soon as possible. Other steps will be required to provide the basic knowledge and confidence that is necessary for the electric utility industry to accept the LMFBR as a dependable power system. This program entails several more decades of effort. The time frame however, does allow the U.S. to develop an indigenous breeder reactor capability if it is pursued expeditiously.

Major research and development programs must be continued to minimize the overall risks associated with the application of breeder reactors. The fruits of the research of the past 25 years however, should be applied and evaluated in a specific demonstration facility to identify those areas where weaknesses point out the need for more concentrated research. The Fast Flux Test Facility (FFTF) is the primary facility for basic material and fuel research. The next prudent and reasonable step is the construction and operation of an appropriate size demonstration facility.

The 375-MWe Clinch River Breeder Reactor (CRBR) is the right size to achieve a prudent extrapolation from the FFTF technology on a path of high confidence. The research and development necessary for CRBR is 96 percent complete, engineering and design is 85 percent complete, many of the major components are fabricated with $610 million worth of equipment already received or on order and design improvements have been incorporated to reflect the most advanced state of the art in LMFBR technology. Any alternative demonstration plant would have an overall higher cost and would not be available within the time frame that is achievable with the CRBR. The cost has already gone up by $857 million due to delays. CRBR should be constructed on an expeditious schedule to minimize unnecessary future delay costs. We are pleased to see the Reagan Administration's support for this goal and note that, as a result, the project is gathering momentum to move head. Completion of CRBR is the next and currently most important step in assuring that our country has access to the LMFBR on a timely basis.

In 1972, the utility industry entered into a cooperative agreement with the Federal Government to support the CRBR. A funding pledge of $250 million was provided from a combination of about 750 electric utility organizations including investor-owned, public and cooperative utilities. This is the largest utility industry commitment ever made to such a program. Proceeding with the construction of the CRBR is a major element to rebuilding the confidence that has been lost for engaging in cooperative industry/ government programs.

The 1981 Annual Report of the Project Management Corporation provides a pictorial and written presentation which includes a brief chronology of the program, the project organization, its significant progress during 1981 and its current status.

The overall LMFBR program also must include the development of the breeder reactor fuel cycle which includes reprocessing, fuel fabrication and the development of systems to resist diversion of fissionable material.

The commitment of the Federal Government is necessary to achieve a successful LMFBR program beyond CRBR. Since there is considerable international interest, cooperative development with foreign governments should be explored so as to minimize the overall costs to all parties for these future efforts.

Spent Fuel Reprocessing

The research and development program at the Barnwell Nuclear Fuel Plant in South Carolina should be continued. The utility industry supported Congressional actions in the past three fiscal years in the appropriation of funds for research and development at Barnwell. We support the Administration's position of encouraging reprocessing of commercial spent fuel to recover the extensive energy values contained therein. Reprocessing should be performed when it is economically justified. The work being continued at Barnwell and the other reprocessing research and development will be enormously valuable in providing the knowledge required to proceed with reprocessing.

Commercial Nuclear Waste Management

Madam Chairman, last year you and your subcommittee led the way in developing legislation designed to provide a framework for a comprehensive nuclear waste management program. We commend you for your leadership because it created the momentum which we hope will culminate this year in Congressional approval of this long-awaited and much-needed legislation.

Funding for the waste repository program is appropriately the responsibility of those benefiting from electricity generated by nuclear power. Our industry is willing to assist in this regard.

We concur with the approach proposed in current legislation for contracts to be initiated between the Federal Government and the utilities to provide for the waste disposal service and for funding the program. We urge Congress to enact nuclear waste management legislation that includes; 1) separate funding, 2) a firm schedule and a disciplined decision-making process, 3) temporary, interim, off-site storage of spent nuclear fuel, 4) direction for Federal/State interactions and 5) an integrated research and development program. The funding provided through the contracts with the utilities should be used for site-specific repository activities. The generic research and development activities should be funded through general appropriations.

Success in the nuclear waste management area will help restore public confidence in nuclear generated electricity and aid utilities in their long-range electricity planning initiatives.

Three Mile Island

EEI supports the current participation of the Federal Government in the cleanup of the damaged reactor at Three Mile Island near Harrisburg, Pennsylvania.

Accordingly, we support the President's FY 1983 budget request for TMI related activities. Significant milestones have been achieved during the past year with respect to cost-sharing proposals which would include the Federal Government, the States of

Pennsylvania and New Jersey, the electric utility industry and the General Public Utilities ratepayers. We are optimistic that a comprehensive program for the cleanup can be achieved, and believe that continued Federal support is an important aspect of that program.

Gas-Cooled Reactors

The high temperature gas-cooled reactor (HTGR) concept has potential for greater operating efficiencies, greater flexibility in reactor siting , and possible application for industrial process heat requirements. Development of the HTGR continues to be supported both financially and with managerial expertise through the utility supported Gas Cooled Reactor Associates (GCRA). Continued Government cooperation and support are vital to the success of the joint effort now underway.

Uranium Enrichment

We urge the Congress to continue its support for the development of gas centrifuge technology for uranium enrichment and the construction of the Gas Centrifuge Enrichment Plant (GCEP). The three gaseous diffusion plants have served the U.S. military, and domestic and foreign commercial nuclear power programs well. The diffusion plants, however, are highly dependent on large quantities of electric energy for their operation. Fifty percent of the cost of present uranium enrichment services is the cost of electricity to operate the diffusion plants. A gas centrifuge process would use only 4 to 5 percent of the electricity used by the diffusion process to produce a unit of separative work (SWU). The GCEP offers obvious benefits both in conservation of energy resources and in potentially reducing the cost to consumers. It is also an important element in maintaining our position in the international community as a reliable and competitive supplier of uranium enrichment services.

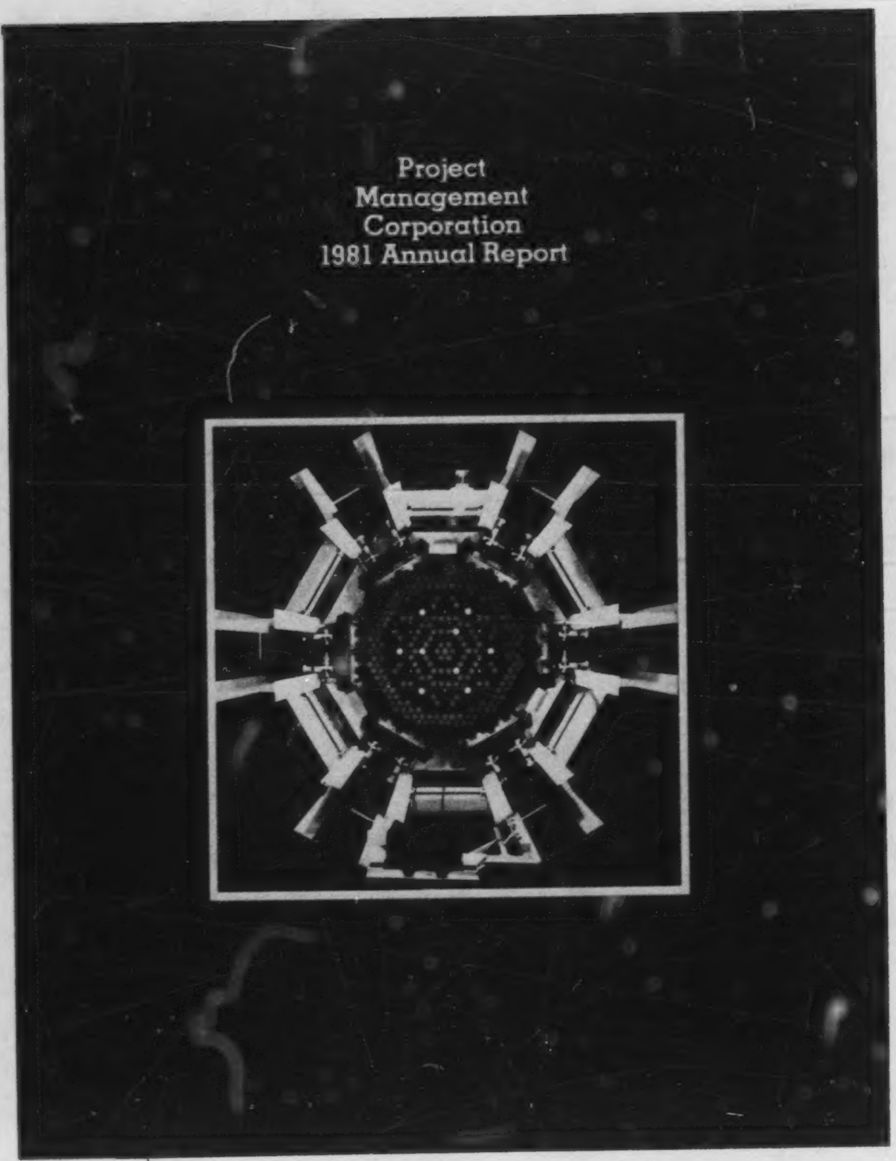
We encourage the development of AIS techniques, which may one day provide an even more efficient form of uranium enrichment. We caution, however, that AIS research and development should not detract from GCEP manufacturing, construction and installation aimed at meeting its present schedule of 2.2 million SWU by 1988 and subsequent increments at Portsmouth, Ohio to a capacity of over 10 million SWU. The GCEP offers a high confidence path for more efficient uranium enrichment while AIS requires major developmental efforts to apply the technology.

Utilities pay the Federal Government for uranium enrichment services on a full cost recovery basis including, in FY 1982, 1983 and beyond, providing the funds for GCEP construction, AIS research and all related activities.

Conclusion

Economic and reliable electric energy must play a greater role in this country and this can be achieved only with the use of nuclear power and coal. Nuclear power is a domestic energy resource that is converted to a high grade flexible energy form -- electricity. Major Federal programs are necessary to permit this potentially large energy resource to be fully developed to serve the nation's growing economy, to displace the use of the world's depleting petroleum where practical and to replace obsolete electricity generating facilities.

Madam Chairman, the utility industry stands ready to assist you on these and related matters. I would be pleased to answer any questions you and the Subcommittee members may have.



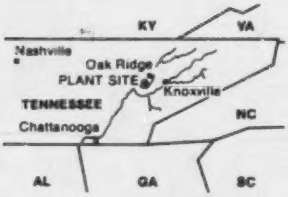
Project
Management
Corporation
1981 Annual Report

A Step Toward Energy Independence

The Clinch River Breeder Reactor Plant (CRBRP) Project in Oak Ridge, Tennessee, is the nation's first large-scale demonstration breeder reactor power plant. A breeder is a nuclear plant that produces more fuel than it consumes as it generates electricity. It represents a resource that could provide a virtually inexhaustible supply of energy. The Clinch River Project is the next step in the nation's ongoing activities to develop the liquid metal fast breeder reactor for eventual commercial deployment.

With a gross electric generating capacity of 375 megawatts, the Clinch River plant will be large enough to provide the residential electric needs of a city of 200,000 people. The plant will operate under contract to the U.S. Government as part of the Tennessee Valley Authority (TVA) System for a five-year demonstration period. TVA has an option to acquire and continue to operate the plant thereafter.

The project is a joint effort of government and the nation's electric utility industry. In all, 753 electric systems from across the country have joined together as Breeder Reactor Corporation (BRC) and pledged $257 million in support of the design, construction, and operation of the Clinch River Project. This is the largest industry commitment ever made to a single research and development project.



On The Cover. An overhead view of the full-scale mock-up of the heterogeneous core at Westinghouse Advanced Reactors Division in Madison, Pennsylvania.

Although this annual report covers the period from October 1, 1980, through September 30, 1981, certain events occurring after the close of the fiscal year are included to ensure that complete information is provided on matters of major consequence to Project Management Corporation.

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Chairman's Report

Wallace B. Behnke, Jr.

I am pleased to report that the Administration and Congress have given the green light to the Clinch River Breeder Reactor Project, thus ending the four-year impasse caused by the previous Administration's efforts to cancel it. A series of recent events now gives the Project a fighting chance to begin work at the site as early as next spring.

On October 8, President Reagan directed government agencies to proceed with demonstration of breeder reactor technology, including completion of the Clinch River Breeder. This is one of five initiatives taken by the President to lift the roadblocks to further development and deployment of civilian nuclear power in the United States.

Following up on the President's directive, Secretary of Energy Edwards wrote me concerning the Department of Energy's plans to complete Clinch River consistent with the government's obligations as set forth in the Principal Project Agreements.

Meeting in Chicago on November 6, the Project Management Corporation Board of Directors reaffirmed its support for the Project and took the actions necessary to authorize release of money for use on the Project. This money, approximately $22 million, was being held pending resolution of the impasse on the Project's future. Complementary affirmative actions were taken by the Breeder Reactor Corporation Board of Directors. The BRC Board has indicated that while uncertainties remain, it appears probable at this time that it will make a call on member systems for one annual payment under the Utility Contribution Agreements on or before July 1, 1982, following review of licensing progress and the Project's financial requirements. Assuming continued progress, annual calls under the Utility Contribution Agreements would be made in succeeding years.

On December 4, the President signed into law legislation containing appropriations of $195 million for the Project in FY '82. This appropriation, in combination with funds to be made available by PMC, will be adequate to fund Project needs through September 30, 1982.

In a letter dated November 30 to Nuclear Regulatory Commission Chairman Nunzio J. Palladino, Secretary Edwards, acting on behalf of the Department of Energy, Project Management Corporation, and the Tennessee Valley Authority, requested authorization from the NRC under 10CFR50.12 to conduct site preparation activities, including site clearing, excavation, and construction of temporary support and certain service facilities beginning in March 1982. Approval of the request will advance the policies of Congress and the Administration in favor of expeditious Project completion, avoid Project cost increases of $120 to $240 million, and yet preserve all essential elements of NRC's environmental, safety, and hearing processes. Full consideration of all relevant environmental issues will be assured under this procedure.

As things stand at the end of FY '81, design and related research and development are essentially complete and more than $600 million of hardware either has been delivered or is on order. The Project is ready to begin site preparation as soon as approval is obtained.

Over $1.1 billion had been spent by the end of September 1981. The design has been continuously updated since Clinch River was first authorized by Congress in 1972 and now incorporates contemporary foreign experience, as well as several first-of-a-kind features such as the heterogeneous reactor core, which will advance international breeder technology.

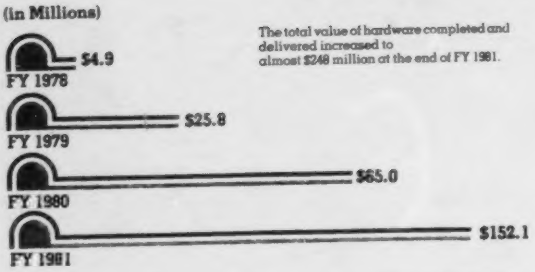
Development and ultimate deployment of the breeder have always been essential to full realization of the vast energy potential contained in our nation's uranium resources. The nation has a high-confidence strategy for ensuring the availability of adequate supplies of electric power at reasonable prices during the next century. That strategy includes development of the liquid metal fast breeder reactor. Completion of a large-scale facility such as Clinch River is a necessary next step in this development. Completion of Clinch River is the quickest, surest, and most economical alternative for achieving this critical national energy policy objective.

Once again, I salute the Project staff for their dedication and performance. All of us associated with the Project remain committed to its successful completion.

Wallace B. Behnke, Jr.
Chairman of the Board

Highlights

Value of Major Components, Prototypes and Test Items Completed and Delivered



The total value of hardware completed and delivered increased to almost $248 million at the end of FY 1981.

Highlights for Fiscal Year Ending September 30

	1981	1980
Total funds spent on the Project	$1.148 billion	$955 million
Funds appropriated for fiscal year to continue Project	$172.4 million	$172.4 million
Value of major components, prototypes, and test items ordered	$608 million	$573 million
Value of major components, prototypes, and test items completed and delivered	$247.8 million	$95.7 million
Number of people employed on the Project	3,500 in 29 states and Washington, D.C.	3,803 in 26 states and Washington, D.C.
Research and development completed	96 percent	90 percent
Project design completed	86 percent	79 percent

Components Delivered in Fiscal Year 1981

Component	Delivery Date	Cost (in Millions)
Intermediate Heat Exchangers (3rd of 3)	10/80	$12.7
Plant Protection System	11/80	3.0
Sodium Pump Drive Systems (6 of 6)	12/80	12.9
Recirculating Pumps	1/81	1.4
Steam Drums	3/81	1.7
Feedwater Heaters	4/81	2.4
Primary Control Rod Drive Mechanisms	6/81	11.1
Reaction Products Separator Tanks	7/81	2.1
IN and EX Containment Tanks	7/81	1.0
Secondary Control Rod Systems — Prototype (3 of 4)	8/81	1.8
Steam Generator — Prototype	8/81	69.2
Sodium Pump — Prototype	9/81	32.8

4 Status of the Project

A New Beginning

1981 was a year of resurgence for the Clinch River Breeder Reactor Plant Project (CRBRP). During 1981, President Reagan issued his statement on nuclear energy asserting that sustained economic growth over the decades ahead will require additional energy supplies — particularly electricity.

"One of the best potential sources of new electrical energy supplies in the coming decades is nuclear power," the President stated.

President Reagan ordered a series of policy initiatives to be undertaken without delay so that nuclear power could make "its essential contribution to our future energy needs." These initiatives included support for the Clinch River Project and his decision to give immediate priority attention to improving nuclear regulatory and licensing processes, dealing with the reprocessing of spent fuel, and instituting means to handle nuclear waste storage.

In referring to the Clinch River Project, the President said:

> I am directing that government agencies proceed with the demonstration of breeder reactor technology, including completion of the Clinch River Breeder Reactor. This is essential to ensure our preparedness for longer-term nuclear power needs.

In implementing the President's directive, Secretary of Energy James B. Edwards reiterated that the Department of Energy was moving aggressively to complete the Clinch River Plant. Secretary Edwards characterized CRBRP as a "key element in the development of Liquid Metal Fast Breeder Reactor Technology" and declared that it was a "vital step in fulfilling DOE's nuclear mission."

Utilities' Commitment To Project

The President's strong affirmation of support for the Project and associated actions reinstituting licensing activities served notice that the federal government intended to concentrate its resources on moving ahead with CRBRP. The policy shift reversed the position taken in 1977 when the Carter Administration called for cancellation of the Clinch River Project.

In response to the positive steps by President Reagan and the Department of Energy, the utility industry reaffirmed its support and financial commitment to the Project.

At a meeting of the Board of Directors of the Breeder Reactor Corporation (BRC) on November 6, 1981, immediate release of up to $22 million of available utility funds to the Department of Energy was authorized for application to the Project. The funds are to be made available through Project Management Corporation (PMC) upon favorable completion of the Congressional appropriations process for Fiscal Year 1982 permitting the Project to move forward in accordance with government-industry agreements first executed in 1972. In addition to the release of these funds, the utilities voted to expend an estimated $8 million for Project operation in Fiscal Year 1982.

Speaking at the BRC Board meeting, Deputy Secretary of Energy Kenneth Davis pointed out that accelerating construction of the Project "could save taxpayers several hundred million dollars."

On behalf of utilities nationwide, BRC Chairman Thomas G. Ayers announced the Board's intention to do its part to support the Administration's efforts to complete the project. The utility industry has already contributed approximately

A detailed excavation model for the Clinch River Plant was completed by Stone & Webster Engineering Corporation, the general construction contractor.

Utilities pledged continuing support for the Project at the Breeder Reactor Corporation Board Meeting. Shown here are Gordon C. Hurlbert, President of Power Systems Company, Westinghouse Electric Corporation; Wallace B. Behnke, Jr., PMC Board Chairman and Executive Vice President of Commonwealth Edison Company; Kenneth Davis, DOE Deputy Secretary of Energy; Robert D. Partridge, Executive Vice President and General Manager of the National Rural Electric Cooperative Association; Alex Radin, Executive Director of the American Public Power Association; and William F. Rolf, General Manager of PMC.

$112 million to the Clinch River Project and has pledged a total of $257 million to build and operate the plant.

Project Status

The design for the plant has been continuously updated and is at the forefront of worldwide breeder reactor development. Progress on the Clinch River Project to date has been significant. At the end of FY 81, the design was 86 percent complete with over 7,000 of the 9,000 construction drawings already produced. The research and development borne by the Project is over 95 percent complete. Virtually all of the major components have been ordered.

Fiscal Year 1981 was a record year in terms of the total dollar value of delivered components. About $152 million worth of hardware was completed and delivered. Over $1.1 billion has already been invested in the Clinch River Project, and at the end of the fiscal year about 3,500 people in 29 states and Washington D.C., were employed on Project work.

The baseline total plant cost estimate of $2.8 billion was made in 1980, and assumed an initial criticality date of 1988. In 1981, reassessment of the total plant cost estimated the total cost at $3.2 billion based on initial criticality in 1990.

The cost and schedule revisions principally reflect the delays imposed on the Project by the previous Administration's stance on the Clinch River Project, and the impact of inflation. The schedule and cost for completion of the Project depend on actions by the present Administration and Congress. Assuming that work on the site gets underway next year, plant operation could begin as early as 1988.

Research and Design

Even though conceptual design of the Clinch River Plant was started about 1973, the design has been continually updated to reflect the latest liquid metal fast breeder reactor (LMFBR) developments at home and abroad. Plant safety features have been continuously reviewed in light of the changing requirements of the Nuclear Regulatory Commission. In addition, a thorough review of the plant design has been conducted to ensure that the lessons learned from the Three Mile Island accident have been incorporated.

The current design reflects substantial improvements adopted from foreign technology and from the results of more than 30 years of basic LMFBR research and development in the U.S.

The Project Office maintains close ties with worldwide breeder science and technology developments through the Department of Energy's foreign technology exchange program and the systematic interchange of information data with domestic programs.

Argonne National Laboratory is conducting major research for the Project at its site near Chicago and at a second site at Idaho National Engineering Laboratory (INEL) near Idaho Falls. The Project utilized the unique testing facilities at INEL for important studies related to materials and safety. Tests at INEL's Zero Power Plutonium Reactor have verified the efficiency of the recently adopted heterogeneous core configuration for the Clinch River Plant (see next page).

Oak Ridge National Laboratory has been another focal point for Clinch River Project research and development activities. These include development of components and hardware, instrumentation and controls, physics, chemistry, computer technology, fuel management, and other crucial support activities.

President Reagan issued a statement on nuclear energy that included a directive to complete the Clinch River Project.

The Department of Energy requested permission to begin site preparation activities in early 1982. Announcing details to the media are: Henry B. Piper, Chief of Licensing, CRBRP Project Office; Percy Brewington, Jr., Deputy Manager for Projects, Oak Ridge Operations Office, DOE; and Richard A. Chidlaw, Assistant Director for Construction, CRBRP Project Office.

The Fast Flux Test Facility (FFTF), located at the Hanford Engineering Development Laboratory (HEDL) near Richland, Washington, is the prime research tool for breeder reactor research. This facility is providing scientists and engineers with data on fuels, materials, and components to build safe, reliable, and economic breeder reactors. In addition, other activities centering on development and testing of components used in sodium environments put HEDL at the forefront of sodium research. Experience at both facilities is being applied to the Clinch River Project.

Engineering Model

Burns and Roe, Inc., the architect-engineer for the Project, began to build a scale model of the Clinch River Plant when conceptual activities were initiated. The model, which supports engineering and design efforts, now occupies an entire room at Burns and Roe headquarters in Oradell, New Jersey, and is close to completion.

Model work throughout 1981 continued in close conjunction with the evolution of engineering and design. Design problems have been identified and resolved with the model well in advance of construction, and the model has facilitated communication among Project participants and the numerous engineering disciplines.

During 1981, greater emphasis was placed on using the model to evaluate new design concepts and engineering change proposals. Over 50 approved engineering change proposals have been incorporated into the model and plant design. The model will continue to be used by engineers to evaluate maintenance and operation procedures as the plant is constructed and after it is placed in service.

As mentioned earlier, over 7,000 construction drawings have already been produced by Burns and Roe. More than 3,000 of these drawings were completed during FY 81. Specifications for major plant equipment are essentially finished.

U.S. Leads In Breeder Core Design

Experiments completed at the end of 1981 on the Clinch River Project's first-of-a-kind heterogeneous core put the U.S. in the forefront of breeder core design. The year-long core experiments were conducted at the Idaho National Engineering Laboratory's Zero Power Plutonium Reactor (ZPPR) in Idaho Falls, Idaho, and verified the accuracy and the analytical models used to design the core.

ZPPR is being used to test an actual mock-up of the Clinch River heterogeneous core. From a neutron physics standpoint, ZPPR measures the characteristics of the CRBRP core at the zero power level.

1. **Tests verifying the superiority of CRBRP's heterogeneous core were conducted using this actual physics core mock-up at the Idaho National Engineering Laboratory's Zero Power Plutonium Reactor in Idaho Falls, Idaho.**

1.

2.

These experiments confirmed that the Clinch River core design can extend fuel life, cut costs, provide greater assurance of safety margins, and breed new fuel with greater efficiency than previous breeder reactor core designs.

The ZPPR experiments helped to verify that all the calculations that predicted improved performance were correct and reduced uncertainties dramatically. The success of this work has been the subject of close scrutiny by Europeans and the Japanese who are building breeders themselves. A technical exchange program has been established to facilitate this cooperation. Foreign breeder programs are expected to adopt the heterogeneous core concept in future plants.

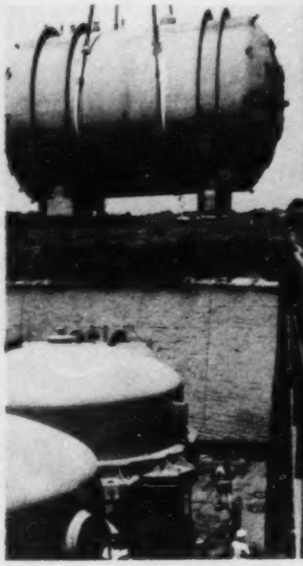
Multiplexing

In FY 1981 studies continued on the incorporation of multiplexing for the control systems in the Clinch River Plant. Multiplexing, an electronic advancement developed by the aerospace and telecommunications industries, is relatively new to the nuclear industry. It enables thousands of signals to be transmitted simultaneously along one circuit. CRBRP will extend the nuclear industry state-of-the-art in this advanced electronics techonolgy. Multiplexing will eliminate 1.6 million feet of cable in the plant, reduce the construction schedule, improve reliability, and decrease plant costs.

Key Systems Design Review

In response to the Three Mile Island accident in 1979, the project advanced the schedule for a comprehensive integrated design review of the systems considered key to the safety of the plant. A Key Systems Design Review Task Force conducted the review as part of the final design effort prior to the procurement of major control room components and associated hardware. The task force looked for deficiencies that could affect the operation of the plant under normal and abnormal plant conditions.

The Key Systems Design Review was completed in 1980 and resulted in a number of recommended plant design changes and procedure modifications. During 1981 these recommendations were evaluated and a number of design changes were adopted. The Key Systems Design Review provides further assurance that there is a sound basis for building the plant as designed and that its key systems are carefully integrated and designed for reliable operation and the highest degree of safety.

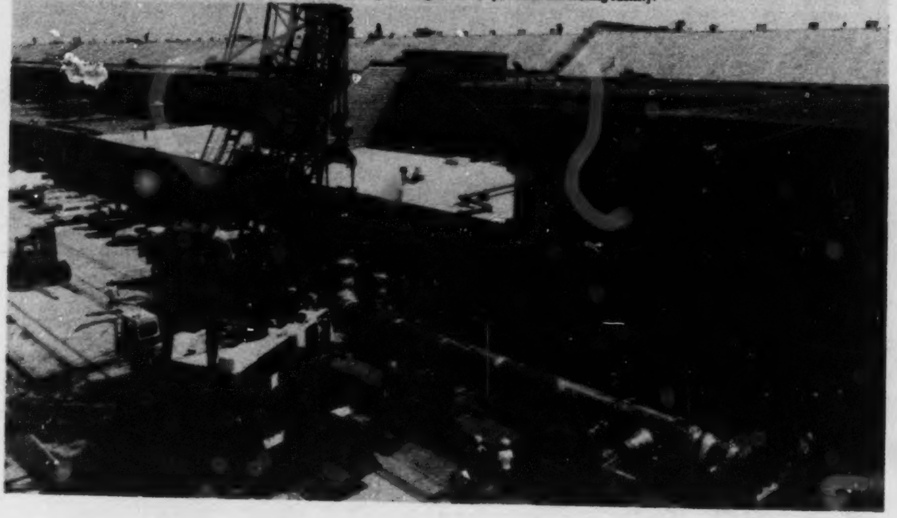


2. Millions of dollars worth of components are now stored in the Project's main warehouse in Memphis.

3.

3. The control room mock-up in Oak Ridge.

The steam generator on route to the Energy Technology Engineering Center (top) and at the testing facility.



Fabrication, Testing, and Delivery

Components, valued at approximately $152 million were delivered to storage sites throughout the U.S. during FY 1981. Over $77 million of these components are now located in Oak Ridge near the plant site. The remainder of the delivered components are in test or storage at other locations throughout the country. These deliveries brought the cumulative value of equipment delivered through the end of the fiscal year to nearly $248 million.

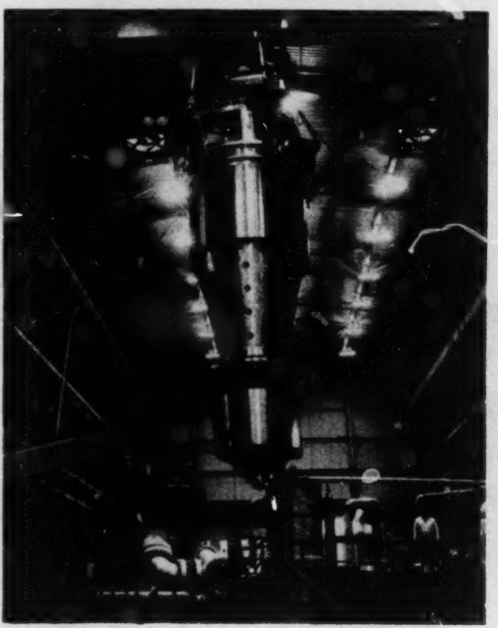
The placement of equipment contracts also continued at a strong pace. The total value of components, test items, and prototypes previously delivered or under contract at the end of FY 1981 climbed to $608 million.

A significant amount of component testing was completed in FY 1981. This testing has provided the data needed to confirm that the design is technically sound and that the components will function within the specifications required for optimum availability, operability, and maintainability.

Among the *major* components delivered for testing during the fiscal year was the prototype steam generator manufactured by Atomics International in El Segundo, California. The prototype was delivered in August to the Energy Technology Engineering Center (ETEC) in Santa Susana, California. The prototype steam generator was rigged into position in the Sodium Components Test Installation support structure. It will be subjected to a series of around-the-clock tests throughout 1982. After three months of testing the system with steam, the unit will be connected to a sodium loop for performance testing under plant conditions.

During this same period, the prototype sodium pump successfully completed water testing at Bryon-Jackson, Inc., in Vernon, California. The pump and pump drive system were then disassembled and shipped to ETEC for installation in the Sodium Pump Test Facility. Pump internals delivery is in progress, and construction and assembly at the Sodium Pump Test Facility are on schedule for initial testing, in sodium to begin in early 1982. The unit will be extensively tested in sodium over the full range of plant conditions. These tests will be concluded in late 1982. The sodium pumps for the Clinch River Project are the most advanced of their kind in the U.S. Each is designed to pump 33,700 gallons of sodium a minute. The pumps represent a significant advancement over earlier models. Even though these pumps are somewhat smaller than the pumps used at FFTF, they are capable of circulating a much larger volume of sodium than the predecessor models.

The Secondary Control Rod System (SCRS) second prototype testing was successfully completed by General Electric in San Jose, California. This second prototype incorporated significant design improvements over the original model which was tested last year. The test demonstrated the ability of the SCRS to perform all of its design functions to shutdown the reactor in the unlikely event of primary control rod system failure. The primary and secondary control rod systems are independent, redundant systems of diverse designs. The primary system is used for reactor startup, control, and shutdown. The secondary system is used for reactor shutdown. Three other SCRS tests were also started in FY 1981.



The prototype sodium pump.

Testing of the prototype electromagnetic (EM) pump was completed in 1981 at ETEC. The pump was fabricated at Atomics International for the Clinch River Plant auxiliary liquid metal system. The auxiliary system provides for receipt, storage, and purification of the coolant to be used in the plant. Sodium testing at extremely high temperatures indicated that the pump met and generally exceeded all performance specifications. It was also shown to be capable, under certain conditions, of delivering 800 gallons per minute — twice its design requirements.

In the tests, the pump also achieved exceptional efficiencies at maximum voltage. This prototype EM pump is a redesigned and improved version of that used in the Fast Flux Test Facility at Hanford, Washington.

Among the major components completed and stored or tested during the fiscal year were the intermediate heat exchangers, the sodium pump drive systems, the primary control rod drive mechanisms, the plant protection system, the recirculating pumps, the steam drums, the feedwater heaters, and the reaction products separator tanks.

Construction

Stone & Webster, the general construction contractor for the Project, accelerated its activities so components could be properly stored in facilities in Memphis and Oak Ridge, Tennessee. Additional warehouse space was acquired in 1981 in Memphis to accommodate the increasing number of components arriving for the plant by barge.

An excavation model of the plant site was developed by Stone & Webster as an aid for construction planning and operations. The excavation model represents approximately 150 acres of the main portion of the site. It was constructed with removable sections to represent both the present topography and the site at completion.

The model is an innovative tool that Stone & Webster is utilizing to assist planning engineers in reviewing earthwork volumes and to develop the best sequencing of earthwork operations. It will be used to verify the milestone schedule for the excavation contract and other site planning schedules, and to establish and verify locations of storage and temporary facilities. In conjunction with the soil borings, the model will assist in identifying areas which could present

Assembly of the reactor vessel closure head at CBI Nuclear Company in Memphis.

problems critical to the overall site preparation schedule. During the construction phase, it will be used to monitor the overall progress and keep the site work on schedule. The model represents the continuing innovations by the Project in construction planning.

Plans were further refined on a special crane with extra-heavy lift capability for the construction of the Clinch River Plant. This huge transi-lift will be capable of making an 800-ton lift — the largest lift expected in building the plant. This crane will be used to position such items as the reactor vessel, the reactor vessel support, containment dome sections, a fully assembled gantry crane, and the reactor vessel closure head. The extra-heavy lift capability allows large components to be assembled outside the plant buildings before installation and eliminates tedious, time-consuming rigging operations which would interfere with and slow down other construction tasks.

Licensing Renewed

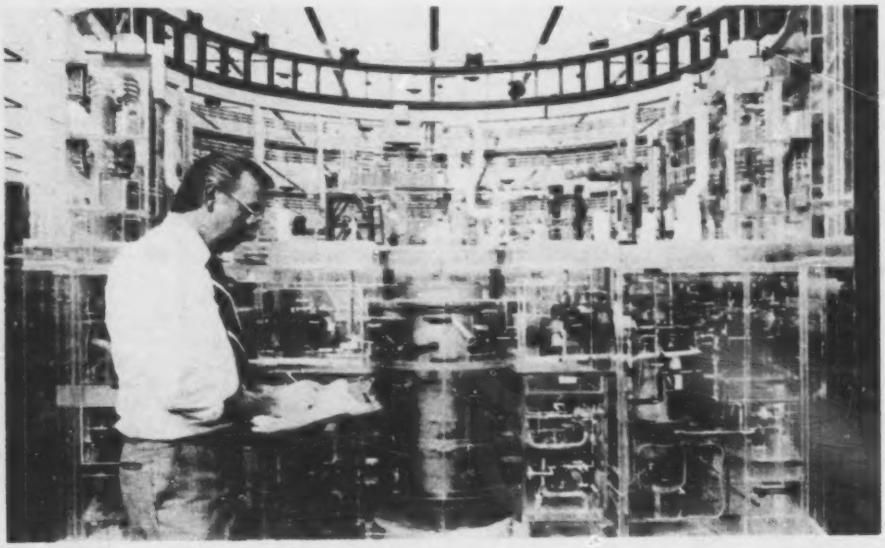
The Nuclear Regulatory Commission (NRC) established an office in September 1981 to renew licensing activities for the Clinch River Project. Interaction with the NRC was initiated earlier by a written request from DOE Deputy Secretary Kenneth Davis to NRC Chairman Nunzio Palladino.

The NRC office will manage and direct the safety and environmental reviews of the CRBRP. In areas in which NRC lacks sufficient expertise on breeder reactor technology, technical assistance will be provided by the national laboratories and other appropriate contractors.

A series of meetings was held late in 1981 to expedite licensing and bring NRC officials and staff members up to date on recent developments. The meetings included briefings by members of the Project Office staff and other Project participants, and visits to the plant site.

The NRC had issued the Final Environmental Statement and Site Suitability Report in 1977. However, the NRC's review of the Clinch River Project's application was suspended immediately following the previous Administration's energy policy message that called for canceling the Project. From April 1977 until September 1981, there was no substantive exchange between the NRC and Project officials although the Project continued to submit licensing material to update the license application.

This model built by Burns and Roe, Inc., the architect-engineer for the Project, replicates the Clinch River Plant in minute detail down to piping one-inch in diameter.



12 Public Policy

Miro Todorovich
Executive Director of Scientists and Engineers for Secure Energy

Hans Bethe
Cornell University

Corwin L. Rickard
President of the American Nuclear Society

Edward Teller
Stanford University

Scientists and Engineers Nationwide Support Project

The consensus view of knowledgeable scientists and energy authorities throughout the United States supports the rapid development of breeder technology and the immediate construction of the Clinch River Project.

Eminent scientists and professional organizations repeatedly addressed the advisability of proceeding with the Clinch River Project. These examinations of the Project's merits encompassed a comprehensive review of evidence pertaining to such critical questions as the plant's technology, the need for the breeder, and the economics of the program.

The support for the Clinch River Project was broadbased and cut across virtually all of the scientific and engineering disciplines.

In a letter to Congresswoman Marilyn Lloyd Bouquard, Scientists and Engineers for Secure Energy (SE2) recommended that funding to build the Clinch River Project be continued and stated that the Project "may become the only reliable technological undertaking of its kind in the Free World." In a major policy statement, SE2 declared that "a substantial majority of the organization's membership is strongly in favor of continuous funding for this most important project." SE2 said the "United States urgently needs the working experience and trained personnel which only an ongoing Clinch River Breeder Reactor Project can provide." This non-profit organization of some 1,000 scholars, scientists, and engineers is dedicated to providing accurate and timely scientific information on energy matters to the public. The association members include several Nobel Prize Laureates and scientists from the nation's most respected universities and research centers.

Two scientists who have contributed substantially to man's understanding of nuclear energy, Manson Benedict of the Massachusetts Institute of Technology and Eugene Wigner of Princeton University, appended personal letters to the SE2 statement. Dr. Wigner noted that "it will be economical to complete the Clinch River Breeder — it will not only produce power, it will also produce experience. Its abandonment would produce discouragement." In his personal statement, Dr. Benedict said that "the liquid metal breeder reactor is this country's best prospect for generating electricity after the year 2000."

The American Nuclear Society, a scientific and educational society of 13,000 scientists, engineers, and educators from universities, government and private laboratories, and industry issued a policy statement recommending construction of CRBRP. "Breeder reactors will be needed if nuclear fission power is to make a significant long-term contribution to world energy needs," the ANS policy statement emphasized. "The United States should return immediately to a vigorous breeder program with emphasis on construction and operation of the CRBRP followed by other breeder facilities on a commercial scale."

The American Association of Engineering Societies (AAES) unequivocally endorsed the Clinch River Project. AAES represents 43 engineering societies with a membership of nearly one million engineers. The association recommended the development of breeder technology and the construction of the Clinch River Plant to ensure preparedness for longer-term nuclear power needs.

At least a score of other prominent scientists and engineers released statements during the year endorsing the Clinch River Project. These endorsements emanated from a spectrum of leading energy experts representing the entire range of private industry, independent authorities, and the government.

International Study Affirms Breeder Value

The International Nuclear Fuel Cycle Evaluation (INFCE), a major study

Clinch River
Breeder Reactor Plant
Project Office

Eugene Wigner
Princeton University

Manson Benedict
Massachusetts Institute of Technology

Robert Frosch- President of the American Association of Engineering Societies

involving 66 countries and five international organizations, addressed the major energy issues facing the world as it moves into the next century. The study was independent and non-political, and therefore did not include policy recommendations. But its comments on the necessity of breeder reactor development clearly indicate a favorable worldwide consensus. Recognizing the prudence of having a number of "robust policy options," the study outlines the benefits of breeders.

INFCE concluded that the growth in energy consumption beyond the year 2000 which is associated with further economic development of human society cannot be provided completely from traditional energy resources — the fossil organic fuels — because of their scarcity. Of the proposals for alternative energy sources which could appreciably extend the presently available fuel resources, it said nuclear power is by far the most important and is already a practical reality. However, it emphasized, the supply of uranium at economic prices is limited, and the fullest utilization of the potential of this energy source can be achieved only by the use of breeder reactors.*

These conclusions closely parallel those of previous studies by the U.S. Department of Energy and the National Academy of Sciences.**

Dr. Teller Supports CRBRP

In 1981 Dr. Edward Teller forcefully expressed his views that the national energy program must include the Clinch River Project. Dr. Teller said he would "support the national Nuclear Power Program as it stands today," including the Clinch River Project, and "make suggestions as to how to ensure the success of our whole nuclear electric power effort."

Dr. Teller agreed to appear in an audiovisual presentation for Breeder Reactor Corporation entitled **Endless Energy** to discuss significant energy issues and to present facts that would minimize public opposition to the breeder project after the research and development phase is completed and deployment begins. (See the Public Information section of this annual report for additional information.)

In making a plea for the United States to consider the best energy choices from the options now available, Dr. Teller concludes his remarks on the Clinch River Project in this passage:

Endless energy, which can now be used for electricity and later for other things, is absolutely needed not only for the stability of the economy of the advanced world, but very particularly for the third world. Because without energy, the developing countries won't develop, they won't even eat . . . .

I am now sitting at the control panel of one of the Oak Ridge reactors. In a few years from now there will be a similar control panel for the fast breeder. I think I can say that there is no other reactor whose safety has been so thoroughly, so reliably, analyzed as that of the fast breeder . . . .

I therefore recommend that we go ahead with the Clinch River Breeder Reactor. We consider carefully how best to do it. We consider all the alternatives of other ways of getting material — getting raw material — for future nuclear energy so that it should last effectively forever. Then we must make the best choice. A very important part of that program is to build — and build well — the fast breeder reactor at Clinch River.***

* **International Nuclear Fuel Cycle Evaluation**, International Atomic Energy Agency, Vienna, 1980, Vol. 9, p. 161.

** **Nuclear Proliferation and Civilian Nuclear Power: Report of the Nonproliferation Alternative Systems Assessment Program**, U.S. Department of Energy, 1980; **Energy In Transition 1985-2010**, National Research Council, W.H. Freeman and Co., 1979.

*** **Endless Energy**, Dr. Edward Teller, Breeder Reactor Corporation, 1981.

14 Directors And Staff

Ayers Honored By Board . . . O'Connor Elected BRC Chairman

The Project Management Corporation (PMC) and Breeder Reactor Corporation (BRC) Boards of Directors passed a resolution at their annual meetings honoring BRC Board Chairman Thomas G. Ayers. Ayers was commended for his "leadership in bringing together the resources of the U.S. electric power supply industry to work with the federal government in building the Clinch River Breeder Reactor Project."

Ayers, who retired as chairman at the BRC Board meeting, headed the Corporation since its inception in 1972. In a special presentation, the Board bestowed a plaque on behalf of the electric utility industry to Ayers to commemorate his dedication to the breeder program and to recognize his ability in guiding the Project over the past decade. Ayers retired in 1980 as Chairman and Chief Executive Officer of the Chicago-based Commonwealth Edison Company.

Elected to serve as the new BRC Chairman was James J. O'Connor. O'Connor is Chairman and President of Commonwealth Edison Company.

"I will strive to work as diligently as Tom Ayers to move the breeder program vigorously ahead," O'Connor told the Board. "The utilities across the country intend to fully support the government and sustain the industry's dedicated commitment to building and operating the Clinch River Plant."

Director Changes

John D. Selby, President and Chief Executive Officer of Consumers Power Company, was designated to serve as the representative of Breeder Reactor Corporation on the Board of Directors of Project Management Corporation. Selby assumed the position on the Board formerly held by William R. Gould. Gould, who is Chairman of Southern California Edison Company, served on the PMC Board since 1972. The PMC Board commended Gould for his years of service on the PMC Board and his leadership in serving to advance the nation's breeder program.

Project Personnel

Staffing at Oak Ridge for the Clinch River Project increased markedly in 1981 in preparation for moving ahead aggressively with licensing and construction activities. The total number of employees in Oak Ridge increased to 417 at the end of the fiscal year, including 104 employees with PMC, 17 with the Department of Energy, 23 with TVA, 23 with Commonwealth Edison, and 3 representing other utilities. Another 74 were employed by Stone & Webster, 130 by Westinghouse, 10 laboratory support personnel by DOE/Oak Ridge National Laboratory, and 33 by other major contractors. This included professional staff members on loan to the Project by the Electric Power Research Institute, Georgia Power, Southern California Edison, and Public Service of Indiana. Nationwide, over 3,500 individuals in 29 states and Washington, D.C., were employed on Clinch River Project contracts.

1. **James J. O'Connor, Chairman and President of Commonwealth Edison Company (left) with retiring BRC Board Chairman Thomas G. Ayers.**
2. **S.H. (Bo) Roberts, President of the 1982 World's Fair, with the electric robot mascot for America's Electric Energy Exhibit (AEEE), Inc., pavilion.**
3. **Groundbreaking for the AEEE pavilion required digging in by William F. Rolf, General Manager for PMC; William F. Willis, General Manager of the Tennessee Valley Authority; Randy Tyree, Mayor of Knoxville; Robert H. Jones, Manager of Marketing and Communications Support, General Electric Company; H.J. Young, Senior Vice President, Edison Electric Institute; and W.E. Lee, Director of Communications and Member Services, American Public Power Association.**
4. **Public Information assistant Sherry Smyrl exhibits the latest audiovisual material from BRC including Endless Energy featuring Dr. Edward Teller, and Energy and the Breeder.**

1.

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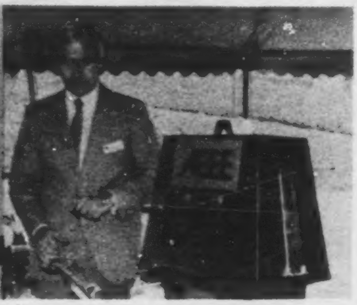


Clinch River Plant At The World's Fair

Breeder Reactor Corporation will be represented at the 1982 World's Fair in Knoxville, Tennessee, with a major exhibit that focuses on the Clinch River Breeder Reactor Plant Project. With its theme of "Energy Turns the World," the Fair is a particularly suitable forum to inform the public on energy issues crucial to the electric utility industry and other energy intensive companies.

BRC was instrumental in helping to organize the pavilion representing the electric energy industry — America's Electric Energy Exhibit, Incorporated (AEEE). AEEE is a non-profit corporation of associations and businesses in the electric energy industry formed especially for participation in the 1982 World's Fair. Members of the Board of Directors include the American Public Power Association, Breeder Reactor Corporation, Edison Electric Institute, General Electric Company, the National Rural Electric Cooperative Association, the Tennessee Valley Authority, and Westinghouse Electric Corporation.

Membership on the AEEE Board of Directors is open to associations and businesses that meet certain qualifying requirements. In addition, AEEE expects to have about 18 other major exhibitors participate in its pavilion. One of the major exhibits in the AEEE Pavilion will be sponsored by BRC.

AEEE holds the distinction of being the largest corporate exhibitor at the 1982 World's Fair with its 20,000-square-foot site. The $2 million AEEE exhibit will be adjacent to one of the most dynamic attractions at the Fair — the U.S. pavilion. More than 11 million visitors are expected to attend the Fair which extends from May through October.

The theme of the AEEE pavilion is "Electric Energy — Key To A Better Future." A segment of the exhibit will portray the ways utilities are working to meet the need for increased amounts of electricity through conservation, load management, and new and improved technology. Advanced technologies such as the breeder reactor will illustrate how nuclear energy can provide adequate energy supplies for centuries to come.

Endless Energy

A major public information initiative in 1981 was the production of an audiovisual presentation featuring renowned scientist and nuclear physicist Dr. Edward Teller.

In a program entitled **Endless Energy**, Dr. Teller explores a number of energy options available to the United States to produce adequate supplies of electricity for future generations. He states the case for developing nuclear energy and describes the technological advances that are taking place to extend our uranium resources and harness endless energy from the breeder and fusion reactors. While inspecting the Clinch River site, he announces his support for making the best choices from our energy options without delay and proceeding with construction of the Clinch River Plant.

This 26-minute color presentation is now available in videotape and 16mm film formats and has been reproduced as a publication. In early 1982 a complete kit with a discussion guide and other collateral material will be released to BRC utilities, schools, and the general public through a nationwide audiovisual marketing firm. During 1982, a projected audience of 250,000 will see **Endless Energy** in its film format. An additional audience of eight million will view the presentation via satellite telecasts on network-affiliated, independent, and educational television stations.

Energy and the Breeder

Early in 1981 a new, general purpose sound-slide presentation known as **Energy and the Breeder** was introduced. The presentation delineates the present energy situation, establishes the need for additional supplies of energy in the future, and demonstrates why coal and nuclear energy are expected to provide increasing amounts of electricity in the future. The nuclear energy framework substantiates the need for developing the breeder reactor and the role of the Clinch River Plant.

Energy and the Breeder has already been seen by hundreds of utilities, professional organizations, and community groups in 41 states. It has also been reproduced as a publication that includes the text and slides.

3.

4.

ENERGY
AND THE
BREEDER

16 Organization And Purpose

Organization of the Project

The U.S. Department of Energy (DOE) has lead responsibility for managing the Clinch River Breeder Reactor Plant Project. Day-to-day management is carried out by a single integrated organization in which the DOE staff members work closely with representatives of the other major contractual partners — Commonwealth Edison Company, the Tennessee Valley Authority, and Project Management Corporation (PMC).

PMC is a non-profit organization formed especially for the Clinch River Project. It represents the interests of the utility industry in the Project. A second non-profit group, the Breeder Reactor Corporation (BRC), provides senior counsel on behalf of the utility industry and keeps the public and the electric power industry informed of Project purposes and progress. BRC is composed of 753 electric systems from the public, private, municipal, and cooperative sectors of the electric power industry that support the Project.

Westinghouse Electric Corporation is the lead reactor manufacturer and is responsible for designing and furnishing the nuclear steam supply system for the Clinch River Plant. Westinghouse is supported by the General Electric Company (Intermediate Heat Transport, Steam Generating Systems) and the Atomics International Division of Rockwell International (Refueling, Auxiliary, Maintenance Systems) as subcontractors.

Burns and Roe, Inc., is the architect-engineer. Stone & Webster Engineering Corporation is the general construction contractor for the Clinch River Project.

Purpose

The Clinch River Plant will employ a type of breeder known as a Liquid Metal Fast Breeder Reactor (LMFBR). "Liquid metal" refers to the liquid metal coolant (sodium) that is used to remove the heat produced in the nuclear reactor.

"Fast" refers to the high speed neutrons that initiate the nuclear fission reaction that produces the heat and permits the reactor to breed.

The principal objectives of the Clinch River Project are:

- To demonstrate the LMFBR's potential value and environmental desirability for generating electric power.
- To help confirm the value of this concept for conserving nonrenewable natural resources.
- To develop important technological and economic data for the benefit of the government, industry, and the public.
- To provide a broad base of experience and information important for commercial and industrial application of the LMFBR concept.
- To verify certain key characteristics of breeder power plants for operation on utility systems. This includes safety and licensability, operability, reliability, availability, maintainability, flexibility, and prospect for economy.

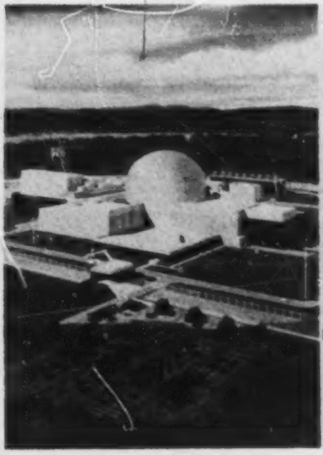
1. The artist's rendering of the Clinch River Plant.

2. The site for the plant.

3. The reactor vessel was completed ahead of schedule and under budget.

4. An intermediate heat exchanger arrives in Oak Ridge.

1.



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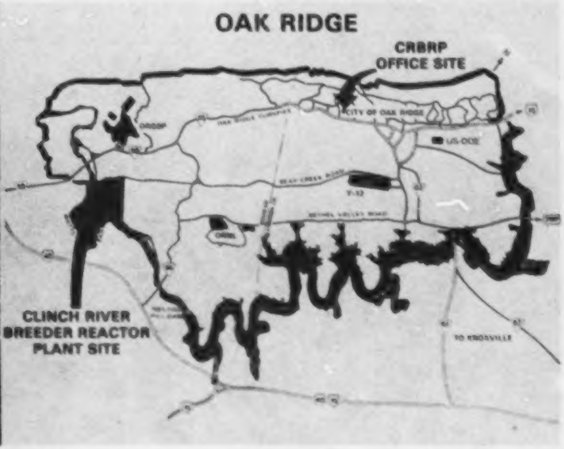

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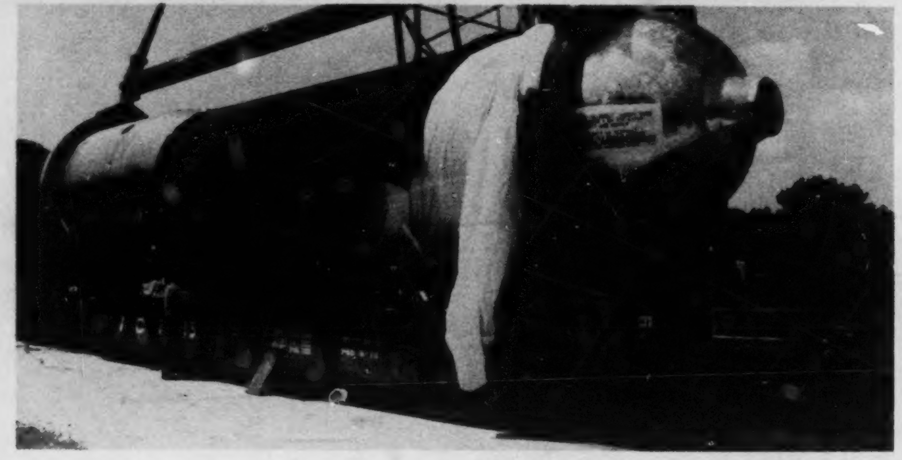

18 Financial Statements

STATEMENTS OF PROJECT COSTS AND ASSETS, CONTRIBUTED CAPITAL AND LIABILITIES AS OF SEPTEMBER 30, 1981 AND SEPTEMBER 30, 1980

PROJECT COSTS AND ASSETS	1981	1980
Project Costs (Notes 2 and 3)	$1,148,213,981	$955,344,717
Less — Project costs financed by DOE and reactor manufacturer contributions	1,023,301,916	836,138,447
Project costs financed by utility contributions	$ 124,912,065	$119,206,270
Indemnification Trust Fund (Note 5)	$ 16,557,100	$ 16,557,100
Current Assets		
Cash and working funds	$ 248,300	$ 123,730
Temporary cash investments, at cost	37,237,973	36,066,024
Accounts receivable	62,601	21,638
Interest receivable	1,519,353	832,526
Contribution pledges and interest on overdue installments receivable (Note 4)	543,262	540,745
Total Current Assets	$ 39,611,489	$ 37,584,663
	$181,080,654	**$173,348,033**

CONTRIBUTED CAPITAL AND LIABILITIES	1981	1980
Contributed Capital		
Utility industry (Notes 4 and 5) —		
Contributions and interest on overdue installments received and due from Breeder Reactor Corporation	$125,362,519	$125,984,991
Earnings on invested utility contributions	30,730,098	25,470,120
Earnings on indemnification trust funds	8,689,464	5,995,953
Contribution credits from Tennessee Valley Authority and Commonwealth Edison Company	3,313,745	2,939,393
Total Utility Industry Contributions	$168,095,826	$160,390,457
Current Liabilities		
Accounts payable to DOE (Note 2)	$12,342,519	$12,342,519
Accounts payable to others	642,309	615,057
Total Current Liabilities	$12,984,828	$12,957,576
	$181,080,654	**$173,348,033**

The accompanying notes are an integral part of these financial statements.

STATEMENTS OF FUNDS COMMITTED FOR PROJECT COSTS FOR THE YEARS ENDED SEPTEMBER 30, 1981 AND SEPTEMBER 30, 1980

	1981	1980
Source of Funds		
DOE and reactor manufacturer contributions	$187,163,469	$184,569,372
Utility industry contributions through Breeder Reactor Corporation	(622,472)	(447,363)
Earnings on invested utility industry contributions and indemnification trust fund	7,953,489	6,738,523
Contribution credits from Tennessee Valley Authority and Commonwealth Edison Company	374,352	374,352
Total Funds Available	$194,868,838	$191,234,884
Add (Deduct) —		
Changes in working capital	(1,999,574)	(1,794,725)
Funds Available For Current Year Project Costs	$192,869,264	$189,440,159
Funds Committed For Project Costs By:		
DOE and reactor manufacturer	$187,163,469	$184,569,372
Project Management Corporation	5,705,795	4,870,787
Total Current Year	**$192,869,264**	**$189,440,159**
Prior years	955,344,717	765,904,558
TOTAL	**$1,148,213,981**	**$955,344,717**

The accompanying notes are an integral part of these financial statements.

(1) Nature of Project

Project Management Corporation (PMC) was organized in 1972 as a nonprofit corporation to manage the design, construction and test operation of a Liquid Metal Fast Breeder Reactor (LMFBR) demonstration plant. Among other things, PMC was to conduct scientific research and to determine, through actual construction and operation of a demonstration plant, the scientific, engineering and potential economic feasibility of liquid metal fast breeder reactors as a practical future source of electric power, to confirm the value of such reactors in conserving nonrenewable resources and to demonstrate their environmental desirability.

An agreement (the Agreement) among PMC, the Atomic Energy Commission (AEC), Tennessee Valley Authority (TVA) and Commonwealth Edison Company (CE) was signed in 1973 to achieve these objectives through the construction and operation of the Nation's first large-scale liquid metal fast breeder reactor demonstration plant (the Project), to be located on the Clinch River in Oak Ridge, Tennessee. In January of 1975, the AEC was abolished, with its nonregulatory activities (including those under the Agreement) being assumed by the Energy Research and Development Administration (ERDA), and its regulatory responsibilities by the Nuclear Regulatory Commission (NRC), respectively. In 1977, ERDA's responsibilities were assumed by the successor Department of Energy (DOE). (Hereinafter AEC, ERDA and DOE are referred to collectively as DOE.) Funds for the Project are provided by the United States Government, CE, TVA, the reactor manufacturers, and by contributions received by Breeder Reactor Corporation (BRC) pursuant to contribution agreements with utilities and public power and cooperative systems throughout the country.

In September 1974, PMC and DOE received from the Project contractors what is called a reference design for the Project. At that time it was estimated that some $1,950,000,000 in plant investment costs, related research and development costs and operating expenses would be required to carry out the Project on the basis of this reference design. (It is currently estimated that total Project costs will amount to $3.2 billion.) Congressional reauthorization became necessary because this revised cost estimate for the reference design substantially exceeded previous estimates. This, together with the need to obtain Congressional approval of a united management structure for the Project, resulted in agreement among the parties to Modification No. 1 (the Modification) of the Agreement, which established revised management arrangements for the Project. The Modification, signed by PMC, DOE, TVA, and CE, became effective May 1, 1976. Under the Modification, the lead responsibility for managing the Project is the undertaking of DOE rather than PMC, PMC's major responsibility being to administer the interests of the utility industry in the Project. This change in management responsibility necessitated, among other things, the assignment of certain contracts between PMC and the Project contractors to DOE. At the same time, title to all property acquired by PMC with Project funds was transferred to DOE.

The Modification calls for PMC to annually review the Project budget and schedules submitted by DOE and, from funds available to PMC, to reimburse DOE an aggregate annual amount not to exceed the lesser of (a) total funds available to PMC less specified reserves, or (b) 50 percent of the projected annual Project budget submitted by DOE.

PMC has secured rulings from the Internal Revenue Service which exempt it from Federal income tax liability. The rulings provide that the Modification will not change its tax-exempt status.

(2) Uncertainty of Project

A number of actions taken by the previous Administration, under President Carter, were intended to lead to termination of the Project. These included an indefinite suspension of Project licensing proceedings in April of 1977. Despite this action and efforts in each subsequent year by the Carter Administration to discontinue funding for the Project, the Congress has appropriated sufficient money in each of the Fiscal Years 1978, 1979, 1980 and 1981 to assure continuation of the Project. Under the circumstances only limited activities could be conducted, primarily engineering, design and procurement of long lead time components.

PMC and BRC, in response to the Carter Administration's actions in 1977, took certain steps to protect the corporations' respective rights and interests, while still supporting the Project. These actions included the following:

1. BRC notified the Administration by letter in June 1977, that the actions of the government were inconsistent with the Principal Project Agreements; and if implemented, would constitute a termination of the Project for the convenience of the government. BRC's letter further stated: "Such a termination, of course, never was intended in the Project arrangements, and would represent a material breach of the Principal Project Agreements."

2. In the fiscal year ended September 30, 1977, PMC withheld quarterly payments totaling $12,342,519, which it otherwise would have made under a cost-sharing agreement with the government. These amounts have continued to be withheld during the fiscal years ended September 30, 1978, September 30, 1979, September

30, 1980 and September 30, 1981 and no further payments will be made until the Project's status is resolved. Since no cost-sharing agreements have been reached, no liability to DOE has been recognized by PMC for FY 1978, FY 1979, FY 1980, or FY 1981.

3. In December 1977, BRC notified contributing utilities and DOE that the 1977 utility contributions otherwise due BRC in December 1977, would be deferred pending conclusion of the governmental decision-making process.

A similar letter deferring the 1978 contribution was sent to contributing utilities on November 1, 1978. At the BRC Board Meeting on October 23, 1979, a resolution was passed also deferring the 1979 and 1980 contributions.

Confirming a complete shift in policy towards the CRBRP, the Reagan Administration has announced its full support for the Project in a formal statement issued by the President on October 8, 1981.

At the BRC Board Meeting on November 6, 1981, a resolution was passed deferring the 1981 contribution installment payment, but authorizing the BRC executive committee to initiate on or before July 1, 1982 a call for one annual installment payment. It is likely that this call for one annual payment will contemplate the collection and application of funds to the project during FY 1982, that is, on or before September 30, 1982. Subsequent calls for the balance of the Utility Contribution Agreement (UCA) payments will also be made annually thereafter, assuming the project continues to go forward.

(3) Summary of Significant Accounting Policies

PMC maintains its accounting records on an accrual basis, and all significant Project costs and liabilities incurred as of September 30, 1981, have been recorded. Project costs principally consist of design, engineering, procurement and other research and development costs related to the Project and include all costs incurred by PMC. Under generally accepted accounting principles, the research and development costs would not be capitalized. The Project costs reported in the financial statements represent only those costs incurred under the Agreement (and the Modification thereto) and are not necessarily all of the costs which have been incurred in the United States for LMFBR technology.

Project costs financed by utility contributions at September 30, 1981, represent those Project costs which were incurred by the Project and which under the Agreement (and the Modification thereto) were to be financed by funds or services received from utilities and public power and cooperative systems comprising the electric utility industry.

(4) Utility Industry Contributions

Utility industry contributions are remitted to PMC by BRC, which is responsible for collecting funds from the electric utility industry to help finance the Project. As of September 30, 1981, 377 Utility Contribution Agreements and two letters of intent in the amount of $257,000,000 have been executed, substantially all of which provide for a specified amount of financial support in ten equal annual installments from 1972 through 1981. Including cash contributions, 753 utilities, public power and electric cooperatives have commited financial support to the Project. Through September 30, 1981, BRC had transferred $125,362,519 of these industry support funds to PMC.

PMC and BRC are parties to a contract which delineates their respective responsibilities with regard to the collection and disposition of utility industry contributions. For the purpose of securing its obligations under this contract, BRC has granted PMC a security interest in all Utility Contribution Agreements held by BRC.

TVA and CE, in addition to their respective Utility Contribution Agreements with BRC, have each agreed to contribute $2,000,000 over a period of ten years through credits against costs for performance of work and services pursuant to the Agreement. Through September 30, 1981, TVA's and CE's credits amount to $1,641,340 and $1,672,405 respectively.

(5) Indemnification Trust Fund

Under the Agreement (and the Modification thereto) PMC and DOE agree to indemnify CE and TVA against all costs or liabilities which may exceed their respective contributions and other commitments to the Project. To secure the payment of these obligations, the Agreement provides that PMC's rights to receive from BRC any monies paid or payable under Utility Contribution Agreements signed by TVA and CE are assigned and pledged to TVA and CE for their joint benefit. Any payments made under these Utility Contribution Agreements are to be deposited in a trust account at American National Bank and Trust Company of Chattanooga, as trustee, pursuant to trust agreements among PMC, BRC, TVA and CE effective May 1, 1976. Under the Agreement among PMC, DOE, TVA and CE (and the Modification thereto), interest earned thereon becomes available to PMC for use in the same manner as other Project funds. The trust monies become available to PMC only upon written consent of TVA and CE.

Under the Agreement (and the Modification thereto) any trust account funds which have not been released to PMC at the time of PMC's final settlement with DOE shall, to the extent such funds are not needed to satisfy indemnity obligations of PMC and DOE, ultimately be paid to DOE together with pertinent interest earned thereon.

22 Auditors' Report

To the Board of Directors of Project Management Corporation:

We have examined the statements of project costs and assets, contributed capital and liabilities of PROJECT MANAGEMENT CORPORATION (a District of Columbia non-profit corporation) as of September 30, 1981, and September 30, 1980, and the related statements of funds committed for project costs for the years then ended. Our examinations were made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

As discussed in Note 3 to the financial statements, Project Management Corporation maintains its accounting records on a basis of accounting intended to report project costs funded by the electric utility industry. Accordingly, the financial statements do not purport to present financial position or results of operations in accordance with generally accepted accounting principles.

As discussed in Note 2 to the financial statements, there are significant uncertainties regarding the continued viability of the project, and the ultimate outcome of these uncertainties is not determinable at this time.

In our opinion, subject to the effect, if any, on the financial statements of the ultimate outcome of the uncertainties referred to in the preceding paragraph, the accompanying financial statements present fairly the project costs and assets, contributed capital and liabilities of Project Management Corporation as of September 30, 1981, and September 30, 1980, and the funds committed for project costs for the years then ended on the above described basis of accounting applied on a consistent basis.

Arthur Andersen & Co.
Chicago, Illinois
October 28, 1981

Financial Resources and Project Costs

Financial Resources and Project Costs

Pledges and cash contributions to the Project from the Nation's electric power systems totaled $257 million as of September 30, **1981**. This remains the largest industry commitment ever made to a single energy research and development project.

This commitment includes 377 Utility Contribution Agreements and two letters of intent, substantially all of which provide for payment in 10 equal annual installments. The balance of funds needed to complete the Project are to be provided by the U.S. Department of Energy from its annual appropriations and other sources.

Through September 30, **1981**, **$168,095,826** has been made available from utility sources. This amount includes paid and accrued utility contributions of **$125,362,519**, earned interest on utility finds of **$30,730,098**, trust fund income of **$8,689,464** and credits from Tennessee Valley Authority and Commonwealth Edison Company of **$3,313,745**.

Costs through September 30, **1981**, total **$1,148,213,981**, of which **$124,912,065** was to be paid for with utility contributions. Liabilities through that date include **$12,342,519** of utility funds budgeted for payment to the government but being withheld by PMC pending satisfactory resolution of issues raised as the result of the government's breach of its contract obligation.

Accrued Project costs through September 30, **1981**, were distributed as shown in the chart below.

	Millions
Westinghouse Electric Corporation	$440.1
General Electric Company	301.5
Atomics International Division, Rockwell International	145.7
Burns and Roe, Inc.	160.0
Stone & Webster Engineering Corporation	21.1
Other Contractors	42.6
Project Management Corporation	37.2
TOTAL	**$1,148.2**

OCTOBER (1980)

A continuing appropriations bill, including funds for the Clinch River Project at the same funding level as FY80, was signed into law by the President. For most of the federal agencies and programs contained in the bill, funding was provided through December 15. However, this additional funding allowed the Clinch River Project to continue at its present pace until April 1981 or until Congress appropriated additional funds to operate the Project through September 1981.

The third and final IHX was delivered to Oak Ridge. The total cost of the three IHXs was $38.1 million.

Over 3,800 persons in 26 states and the District of Columbia were employed on the CRBRP Project.

The first part of an 11-component system of closed feedwater heaters was placed into storage near the plant site.

NOVEMBER

TVA Chairman S. David Freeman reevaluated his position on CRBRP after a briefing by the Project staff and a tour of foreign breeders and pledged the continued support of the Tennessee Valley Authority.

Eight components were delivered to Oak Ridge — the Reactor Shutdown System of the Plant Protection System, two low-pressure feedwater heaters and a drain cooler, three condensate pumps, and a motor generator set for one of the main sodium pump drive systems.

DECEMBER

A continuing resolution containing more than $80 million for the Clinch River Project was passed by Congress and signed into law on December 16. This additional funding enabled the Project to continue at its then-current pace through September 1981.

Components delivered to Oak Ridge included a high-pressure feedwater heater, the reactor closure head personnel platform, 151 valves, one motor-generator set, and miscellaneous sodium pump drive equipment.

JANUARY (1981)

Three motor support stands, three pump motors, gaskets, and bearings for the steam generator recirculation pumps were delivered to Oak Ridge.

MARCH

A contract for the $10 million upper internals structure of the reactor vessel was awarded to Combustion Engineering, Inc., of Chattanooga, Tennessee.

Testing of the prototype electromagnetic pumps for the plant's auxiliary liquid metal system was completed at the Energy Technology Engineering Center in Santa Susana, California.

The Reagan Administration budget for the Department of Energy proposed $254 million for FY 1982 for the Project. The House Subcommittee on Energy Research and Production approved the $254 million figure. The Administration also proposed a supplemental appropriation of $50 million for FY 1981.

Three $1.7 million 96-ton steam drum vessels for the steam supply system were delivered to Oak Ridge.

APRIL

The final components of the $2.4 million closed feedwater heater system were delivered to Oak Ridge.

Tennessee State Joint Resolution No. 14 urging Congress to restore funding for the Clinch River Project was passed by the Tennessee General Assembly. The resolution was sponsored by State Representative Randy McNally and State Senators James Elkins and Victor Ashe, and was signed by Governor Lamar Alexander.

The reactor vessel closure head was completed and readied for testing.

Under a Department of Energy decision to realign its field structure, the CRBRP Project Office was assigned to report to the Oak Ridge Operations Office.

MAY

The House Science and Technology Committee passed an energy projects authorization bill containing a clause to terminate the Clinch River Project. The following day, a vote was taken to table actions of further consideration of the termination issue. The House committee then voted to appropriate $44.5 million to terminate the Project.

The full House passed a supplemental appropriations bill which included $50 million to fund the Clinch River Project through the end of Fiscal Year 1981. The total funding level for FY 1981 was $172.4 million. Discussions of CRBRP were not conducted during the debate on supplemental appropriations.

The Senate Energy and Natural Resources Committee approved by voice vote the Department of Energy authorization bill for Fiscal Year 1982 which authorized $254 million for CRBRP for FY 82.

The Atomic Industrial Forum published a report containing facts supporting the conclusion that CRBRP is superior in many respects to similar facilities planned or under construction overseas.

JUNE

Six Primary Control Rod Drive Mechanisms and Drivelines valued at approximately $11 million arrived in Oak Ridge for storage after successfully passing a series of tests.

The Conference Report on supplemental funding for FY 1981 was passed by both Houses of Congress. There was no debate involving CRBRP. The bill was signed by the President as Public Law 97-12.

The Budget Authorization Reconciliation Bill was introduced into the House as H.R. 3982 and approved by the budget committee and the full House. The bill authorized $228 million earmarked for the Clinch River Project in FY 82.

The Senate version of the Budget Reconciliation Bill, S. 1327, was introduced and approved by the budget committee and passed by the Senate. The bill authorized $254 million for the Clinch River Project in FY 82.

Scientists and Engineers for Secure Energy called for completion of CRBRP as "the only reliable technological undertaking of its kind in the Free World."

The American Nuclear Society issued a policy statement recommending that CRBRP be built.

JULY

The Energy and Water Development Appropriations Bill, House Resolution 4144, was introduced and approved by the Appropriations Committee. The bill included $228 million for the Clinch River Project in FY 82. An amendment to delete funding for the Clinch River Project was defeated.

Edward Teller visited Oak Ridge for videotaping a nuclear statement which supported CRBRP.

The House of Representatives Subcommittee on Oversight and Investigations held a public hearing to examine allegations about the Project contained in a preliminary staff report and various newspaper reports. Witnesses testifying on behalf of the Project were Shelby Brewer, Assistant Secretary for Nuclear Energy, DOE; Robert Stalker, Director of the Office of Reactor Research and Technology, DOE; Lochlin Caffey, Clinch River Project Director; and William Rolf, General Manager, Project Management Corporation.

An amendment to delete funding for the Clinch River Project during full House discussion on H.R. 4144 was defeated, and H.R. 4144 was passed by the full House.

A barge carrying the three in- and ex-containment sodium storage tanks and the six reaction products separator tanks for CRBRP arrived in Memphis. The components, worth about $2.8 million, were shipped 2400 miles from Camden, New Jersey, via the Inland Waterway and the Mississippi River.

AUGUST

The conference report resolving the differences between the House and Senate Budget Authorization Reconciliation Bills for FY 82 was issued, passed by both Houses, and forwarded to the President for signature. The bill was signed by the President on August 13 as Public Law 97-35. It authorized an appropriation of [illegible] million for the Clinch River Project.

The Department of Energy's National Energy Policy calling for speedy completion of CRBRP was released.

The prototype steam generator was delivered from Atomics International Division of Rockwell International, Inc. to Energy Technology Engineering Center in Santa Susana, California, for installation, checkout, and performance testing.

SEPTEMBER

The Energy and Water Development Appropriations Bill, H.R. 4144, was passed by the Senate Appropriations Subcommittee in September. The full Senate Appropriations Committee did not consider the Bill before the end of Fiscal Year 1981. However, the Senate passed a continuing resolution on September 30 which maintained Clinch River Project funding at the FY 81 level through November 20, 1981.

The mock-up of the Upper Internals Structure was delivered to Combustion Engineering in Chattanooga, Tennessee, to aid in development of assembly procedures that will simplify fabrication.

The Nuclear Regulatory Commission's Office of Nuclear Reactor Regulation established a program office to conduct the NRC staff's licensing review of CRBRP.

Testing of Prototype 3 of the Secondary Control Rod System began at General Electric in San Jose, California.

America's Electric Energy Exhibit, Inc., (AEEE) held the first corporate groundbreaking of the 1982 World's Fair for a $2 million pavilion. Breeder Reactor Corporation announced it would sponsor one of the major exhibits in the AEEE pavilion.

Corporate Information

Wallace B. Behnke, Jr.

John G. Holmes, Jr.

John D. Selby

Cordell Reed

Charles E. Winn

Raymond P. Bachert

William F. Rolf

Raymond L. Copeland

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The Nation's First Large-Scale Demonstration Breeder Reactor Project

Mrs. **Bouquard**. Thank you very much, Mr. Kearney.

Mr. Dubrow?

Mr. **Dubrow**. Madam Chairman, thank you very much. It is a real privilege to be here and appear before the committee. I speak for the more than 1,000 rural electrical cooperatives in 46 States that actually deliver power to 75 percent of the land mass in the continental United States and serve 25 million people.

I appear here today in my own behalf, but also for Mr. Partridge who is away from the city and unable to be here. Mr. Partridge is a member of the board of directors of the Project Management Corp. which supervises and directs the work which has taken place up until now and will take place until we finish the Clinch River breeder reactor.

In that connection and because of the importance of what he said, I would like to read for the committee excerpts from a speech that Mr. Partridge presented on February 7 at the Ninth Energy Technology Conference.

Mr. Partridge said:

> The utility industry is at the frontline of the battle to provide the safest, cleanest, and most economical energy to the nation both now and in the future—and to provide it in amounts sufficient to guarantee our ability to support the needs of a growing population and a rapidly expanding workforce. As you know, this is a full-time job, involving a close working knowledge of economics, evolving regulatory requirements, availability of resources and future energy needs. In this capital-intensive environment, it also requires hard choices about where to direct our resources for maximum gain.
>
> The dangers in making these choices are at least twofold. First is potential shortsightedness—meeting.our short-term economic needs at the expense of a secure energy future. Second is the danger of making the wrong choice, or foreclosing energy options that may one day prove essential.
>
> Regardless of whose prediction of future needs we choose, we must recognize the limitations of all our currently viable energy resources. Even if the population and its energy demands were to stabilize today, the curves of constant demand yet decreasing supplies will inevitably cross. Whether this occurs in the near term or in the remote future is the subject of much controversy, but it will occur unless we secure the means to replace or indefinitely extend these resources.

In that same speech, Mr. Partridge went on to point out that the breeder, as a minimum, would multiply our energy capability sixtyfold and would provide electricity at reasonable costs to our people for centuries.

I had the privilege of serving on the ad hoc energy committee which the Secretary of Interior named in 1951 when he was asked the question of whether or not we should support a nuclear power program. In arriving at a recommendation, we examined the availability of resources within the United States. We came to the conclusion that beginning about 1975 we would no longer be self-sufficient in oil and that these resources ought to be preserved for the petro-chemical industry and for future generations.

On that basis, I joined in the recommendation which the Secretary of Interior made to President Eisenhower in which we recommended that he go forward with nuclear power.

Certainly, subsequent events have demonstrated that the committee was right. I later went to work for the Atomic Energy Commission, as I mention in here, and it is my belief—and I think it can be readily demonstrated—that if we had been able to proceed with the nuclear powerplants that were actually in the program at the time that I worked for the commission between 1970 and 1972, I don't honestly believe that we would have had OPEC and we would be in the position we are in on oil imports today.

One other thing that I would like to state for the record is I remember back as we got into World War II—and I know that goes back a long time—it is my conviction that if we had not had available to us the power resources which we could call on, specifically, some of the hydroelectric resources in the Tennessee Valley and in the Pacific Northwest, we would have been in great trouble.

One of the problems that we face today is some people are saying, "Well, we have got all the electricity we need." However, the truth of the matter is if you look at the record, the growth of our economy and the quality of life of our people is inimicably tied to the growth to the electric utility industry. The breeder reactor is the thing that we will need, and it will come on stream at the time when it is needed.

I would just like to point out that our cooperatives—as I have pointed out in my statement—have already made firm commitments and actually own 4,300 megawatts of nuclear power of which they have already paid out $7 billion. They are in the process of negotiating agreements which will more than double their nuclear capability.

To get back to Clinch River, we actually have 432 cooperatives that have actually contributed funds towards its successful completion.

I say in my statement that we support the gas reactor. We, of course, support the recycling and reprocessing of nuclear fuel.

I attach to my statement, Madam Chairman, a summary of a number of resolutions which were unanimously passed in Atlanta on the 10th of February in support of not only the Clinch River breeder reactor but the whole breeder reactor program and the gas reactors and the other things that we think it is essential for our country to do if we are to have the energy available that we need at the time we need it.

I will not take the time of the committee to read each one of these, but you will find that each one of these resolutions which I have attempted to summarize, and the more important ones which I have actually attached to my statement, fully support the nuclear power program and all aspects of it.

I appreciate this opportunity to appear before the committee. I will be pleased to answer any questions.

It is my understanding that at this time we are going to show the film which gives us a progress report on Clinch River.

[The prepared statement of Mr. Dubrow follows:]

STATEMENT OF MORGAN D. DUBROW
NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION

Before
The Subcommittee on Energy Research and Production
Committee on Science and Technology
House of Representatives

March 10, 1982

Mr. Chairman and members of the Subcommittee, my name is Morgan D. Dubrow. I am the Senior Staff Engineer of the National Rural Electric Cooperative Association (NRECA). NRECA is a national service organization representing about 1000 rural electric systems in 46 states. These systems, mostly all cooperatives, serve more than 25 million consumers in 2600 of the 3100 counties in the United States. Members of NRECA provide electricity to about 75 percent of the land area of this nation.

I appreciate the opportunity to express our views to the Subcommittee on the country's Breeder Reactor Program. We join with the other panelists in urging the Subcommittee to continue to support the Clinch River Breeder Reactor Project (CRBRP). Mr. Robert D. Partridge, our Executive Vice President and General Manager, is on the Board of the Project Management Corporation for the Clinch River Project. He asked me to state for the record his strong personal support for this important facility. At the 9th Energy Technology Conference held here in Washington on February 7, Mr. Partridge presented an overview and update on the Clinch River Breeder Reactor Project. In his presentation, Mr. Partridge said:

> "The utility industry is at the front line of the battle to provide the safest, cleanest, and most economical energy to the nation both now and in the future -- and to provide it in amounts sufficient to guarantee our ability to support the needs of a growing population and a rapidly expanding workforce. As you know, this is a full-time job, involving a close working knowledge of economics, evolving regulatory requirements, availability of resources, and future energy needs. And, in this capital-intensive environment, it also requires hard choices about where to direct our resources for maximum gain.

> "The dangers in making these choices are at least twofold. First is potential shortsightedness -- meeting our short-term economic needs at the expense of a secure energy future. Second is the danger of making the wrong choice, or foreclosing energy options that may one day prove essential.
>
> "Regardless of whose prediction of future needs we choose, we must recognize the limitations of all our currently viable energy resources. Even if the population and its energy demands were to stabilize today, the curves of constant demand yet decreasing supplies will inevitably cross. Whether this occurs in the near term or the remote future is a subject of much controversy, but it will occur unless we secure the means to replace or indefinitely extend these resources.

The utility perspective on the CRBRP presented by Mr. Partridge may be summarized as follows:

> "Because the increase the efficiency of uranium utilization by a factor of 60, breeder reactors are essential to the energy mix that will enable the United States to meet long-term energy needs. Because of its advanced design, sound management, and high level of accomplishment, the Clinch River Project is necessary to the ongoing U.S. program to advance the breeder to the point of commercial deployment. The project must be continued to preserve the confidence of the taxpayers, utilities, private industries, and research institutions that have contributed to its success. Discontinuation in favor of another alternative, even of a larger plant with essentially the same objectives, would undermine this confidence, gain very little technologically, and cast doubt on the reliability and efficiency of the final product."

It is my firm belief that had America gone forward with the nuclear power development projected when I was with the Atomic Energy Commission in 1970-72, there would have been no OPEC with its attendant disruption in our economy. This situation can and must be remedied before America can have energy independence. The utility industry needs Congress' support in going forward with the development of nuclear power and the construction of nuclear power facilities.

NRECA has been a strong supporter of nuclear power production since the inception of the program by President Eisenhower in the early 1950s. The Elk River Plant, which was started in 1956 and completed in 1960 by the United Power Association, was one of the early efforts to produce electricity at small nuclear power facilities. The LaCrosse Nuclear Generating Station of the Dairyland Power Cooperative began commercial operation in 1969 and is continuing to help serve our consumers in Wisconsin. At the present time there are a total of 21 generation and transmission cooperatives which are engaged in joint ventures for the production of nuclear power in 18 states. Our cooperatives own at the present time over 4300 megawatts of nuclear power in joint ventures and are committed to repay in excess of $7.0 billion for this power supply.

In order to achieve the long-term benefits of nuclear power, our Association has supported the development of the Clinch River Liquid Metal Fast Breeder Reactor since its inception. In fact, some 432 of our cooperatives are participants in the contractual arrangements between the U.S. Government and the utility industry for the design, construction and operation of this power facility. We are firmly convinced that completion of Clinch River is a necessary step in the commercialization of the breeder program. It, in fact, is the only assured means of serving electricity needs of our country along with the use of coal. It is our view that building the Clinch River Project is the thing to do right now and we should go forward with this effort.

Our Association also supports the continued development of the High Temperature Gas-Cooled Reactor (HTGR). This nuclear facility has a potential for greater operating efficiency and greater flexibility in locating the power plant and has a potential for providing industrial heat requirements. NRECA urges the Subcommittee to continue the support of gas-cooled reactors.

We are of the view that the Federal Government should provide for processing and storage of nuclear fuel in order that residual fissionable uranium and newly generated fissionable material which (through recovery and recycling) can generate up to 50 percent more energy from the same fuel to provide the equivalent of over one-half of the nation's proven oil reserves. Forthright action should be taken by the Federal Government to construct and to place in operation a repository for permanent high level waste disposal at the earliest possible time as a part of a national nuclear waste disposal program developed in partnership with appropriate state governments.

We ask the Subcommittee to provide continuing leadership and encouragement to the nuclear industry to build upon the lessons learned from Three Mile Island which has already led to improved safety in design, construction and operation of nuclear power facilities.

We seek the assistance of the Congress in going forward with an aggressive program for development and commercialization of the breeder reactor to insure sufficient fissionable resources for an independent energy future for America in the twenty-first century.

On February 10, 1982, at NRECA's 40th annual meeting in Atlanta, Georgia, our membership adopted a number of resolutions in support of a revitalized nuclear power program for our nation. Copies of these resolutions are appended to this statement. Salient features of these resolutions are as follows:

- We urge the Administration and the Congress to set policy and provide leadership and support for an aggressive nuclear power program.
- Positive action is needed to improve nuclear safety and allay the fears of the public regarding readiation exposure and physical destruction of property. Congressional recognition and support are necessary for the Nuclear Safety Analysis Center (NSAC) and the Institute of Nuclear Power Operation (INPO) to insure safe design, construction and operation of nuclear power plants.
- We urge the Subcommittee to encourage the Nuclear Regulatory Commission to simplify and shorten the nuclear licensing procedure by the issuance of limited work authorizations, construction permits and operating licenses.
- The Federal Government should continue to own and operate nuclear enrichment facilities and provide for the additionally needed nuclear fuel enrichment capacity.

- We suggest that the Congress authorize and implement a program which recycles spent nuclear fuel and stored potential nuclear fuel to take advantage of present reprocessing technology, thur utilizing these valuable energy resources.
- The Congress is urged to continue its support of the LMFBR and the gas-cooled reactor programs, and to promptly construct the Clinch River Liquid Metal Fast Breeder Reactor.
- We ask that the Subcommittee authorize the Government to utilize the results of the research and studies already performed to go forward with an effective Waste Management Program which can be achieved with no serious public health and safety or environmental effects.

NRECA is cooperating with the Electric Power Research Institute in its efforts to provide the technological improvements that will enable us to provide energy to our consumers at reasonable cost.

We are confident this Subcommittee will provide the leadership and guidance that will assist the electric utility industry to build the coal and nuclear power plants to help meet our nation's energy needs.

I appreciate the opportunity to submit our views.

Enclosures

RESOLUTION

Government Support for a Revitalized Nuclear Program

The availability of adequate amounts of power and energy are vital to the future growth and security of our nation as a leader of the Free World. As a direct result of uncertainty, indecision and deliberate delay on the part of the federal government, our nation faces the long term prospect of energy shortages, declining productivity, spiraling inflation and increasing inability to compete in the international marketplace, resulting in growing unemployment and potential civil unrest.

Any honest and realistic examination of the power outlook in America today clearly indicates that if the nation is to deal effectively with these growing energy-related problems, nuclear power must play a significant role for the foreseeable future.

Because of the decline in the planning in construction and the cancellation of nuclear power plants , this country will necessarily have to place an ever growing reliance on coal as its primary source of fuel for the generation of electricity. We feel such a trend to be both environmentally and economically irresponsible and as a consequence socially and politically unacceptable.

We therefore recommend that the federal government set policy, and both the Administration and the Congress provide leadership and support for an aggressive nuclear program. It is of vital importance that positive action be taken to:

1. Allay the fears of the American people regarding radiation exposure and physical destruction of property from nuclear plant accidents by stressing the work of the Nuclear Safety Analysis Center (NSAC), and the Institute of Nuclear Power Operation (INPO) whose functions are to insure excellence in the safe design, construction and operation of nuclear power plants.
2. Encourage the nuclear industry to plan and construct nuclear power plants.
3. Simplify and shorten the nuclear licensing procedures, encouraging the issuance of needed limited work authorizations, construction permits and operating licenses on a timely basis.

RESOLUTION

The Breeder Reactor & Nuclear Energy Research

We are deeply concerned by any de-emphasis of nuclear power as a viable power option for the future and the resulting neglect of research and development involving nuclear power in general and the breeder reactor in particular.

There is presently in storage nuclear fuel resources adequate to supply the nation's electric energy requirements for the next century, provided we elect to use the breeder technology. Under present national policy [illegible] wasting 99.1% of the fuel available for use in light water reactors. Given the finite limitations on energy available to the world community of nations, we can ill afford the luxury of turning our back on this virtually inexhaustable resource.

We urge the new administration to move expeditiously in reaching the decision, based upon existing research information, to provide the administrative framework within which a viable nuclear technology, including the breeder option, can be developed and reinstituted. Such decisions must address the need for insuring sufficient fissionable resources and enrichment capacity, providing development of fuel reprocessing facilities, a breeder fuel cycle and a permanent disposal technology for high level wastes. We also urge prompt construction of the Clinch River Liquid Metal Fast Breeder Reactor.

Such action will permit our nation to begin to regain its leadership role in the international nuclear community and will materially lessen our dependence upon foreign energy sources, strengthening our nation both economically and politically.

RESOLUTION

Nuclear Enrichment and Reprocessing

We believe that the federal government should continue to own and operate its gaseous diffusion and centrifuge facilities for the enrichment of uranium for nuclear fuel. Any other action would unnecessarily tend to raise the cost of fuel used in nuclear generating stations or reduce competition between different fuels available for the commercial production of electric energy.

We recognize that the capacity of existing United States nuclear fuel enrichment plants is not adequate to support a sound nuclear program for this country.

In view of the evolvement of special problems such as time, investment capital, national security, monopoly, and international trade which are involved, we believe that the Congress should continue to provide adequate funds so that the U.S. Government can supply the needed additional nuclear fuel enrichment capacity.

We also urge the Administration and Congress to implement a program which recycles spent nuclear fuel to take advantage of reprocessing technology which exists today. The resulting recovered uranium and plutonium are valuable economic resources which should be utilized rather than stored as present policy directs.

RESOLUTION

Nuclear Waste Disposal

Radioactive waste management has been the subject of countless studies and reports. The overwhelming consensus of these studies is that radioactive waste can be handled and disposed of safely, with no serious public health and safety or environmental effects.

Many competent groups have determined that the technology and means are at hand to safely store and dispose of nuclear waste and nearly all of such waste is generated by the federal government's weapons program.

We urge the federal government to immediately provide and implement an affirmative policy and program for the safe storage and disposal of nuclear waste.

Mrs. **Bouquard**. We certainly will. Thank you for your fine testimony, and all of your testimony will be included in the record.

I think we are now going to have the film. If any of you have trouble seeing it where you are, I hope you will feel free to move about so that you all can view the film.

[Film shown.]

Mrs. **Bouquard** Thank you very much for that very fine film. It was certainly very informative. I certainly wish we could have had more members to view it, and I hope that they will avail themselves the opportunity to see the film in the coming weeks.

We will now proceed with our witnesses. Mr. Richards, I believe you are our next panelist.

Mr. **Richards**. That is a hard act to follow, but I will do my best.

Mrs. **Bouquard**. I think I have to relate to that, too, but I think you are the man for the hour.

Mr. **Richards**. My name is Robert B. Richards. I am general manager of the Advanced Reactor Systems Department in Sunnyvale, Calif. We, as you know, have been involved for many, many years in the development of the breeder technology.

We are pleased to have this opportunity to submit our views on the breeder and the role of this technology in the future energy of the country. Of course, the remarks I will be making today we have articulated many times before your committee.

We have been active, as I have mentioned, in the National breeder program since the late 1950's or early 1960's. We think that in general we have contributed importantly to the progress that has been realized over the years, and we feel that a very substantial progress has been realized.

We still continue to believe that the fast breeder progran will be needed as part of a long-term nuclear energy capability. The administration, also, with its stated policy that Government support will be provided for high-payoff and high-risk energy options, has also expressed its support for a liquid metal fast breeder reactor program.

The high payoff for the breeder technology, as we have said before, includes its potential for extending uranium reserves for many hundreds of years. It does constitute an important insurance policy for future energy security.

Now, the slowdown in the rate of building light water reactors and a total lack of new orders has raised new questions about the timing of proceeding with the LMFBR program, and I will deal with this point a little later.

In recognition of this problem in the nuclear energy pace, the nuclear energy policy statement issued late last year by the administration supports the need for nuclear power and addresses several of the deep-seated institutional problems that have caused this slowdown and lack of orders.

We, in GE, stand ready to work with the administration and the Department of Energy to arrive at an effective solution to these institutional problems. As many of you on this committee know, we are working now very diligently to provide a modus operandi for licensing LWR's that should improve the effectiveness of this process. We are hoping that if we can gain some progress here, we can carry some of our ideas over into the area of breeder licensing as well.

The President's nuclear energy policy statement also endorsed the completion of the Clinch River project.

General Electric has consistently supported the need for the Clinch River demonstration plant if an LMFBR program is to be successful. All countries active in breeder development have felt this step to be essential. We should remember that the evolution of the light water technology involved the equivalent of many demonstration plants on its way to commercialization.

Transition to private industry of the LMFBR program, while many years away, would require the Government program to be carried to the point that industry collectively can accept the risk involved in building the next larger scale plant.

Such a follow-on Government program should include detail plant design. There is some of this going on now in terms of the LDP program sponsored by the Department of Energy. It should also include supporting component development, fuel cycle development, and safety and licensing studies. Carried to the proper level of detail, such a program, we believe, could provide industry confidence in costs and engineering risks and permit an eventual decision concerning industry acceptance of a commercial type venture.

We mentioned earlier the impact of light water reactor slowdown on the schedule for LMFBR development. This has posed some uncertainty on the timing of the breeder commercialization. We believe that the pace of the Government's development program—this follow-on program I mentioned earlier—would be paced to relate to the growth rate of the light water nuclear industry into the future. However, we think that the Department of Energy, working with the utility industry and the reactor manufacturers, could develop the pace for this follow-on Government program. This will not be an easy planning activity, but it should be possible to build flexibility into the program to adjust to the proper level as we gradually rejuvenate the light water reactor industry.

General Electric has in the past and will in the future make its resources available to carry out the federally supported LMFBR development program and participate in the industry to follow if it becomes an acceptable business risk.

We appreciate your attention today, and stand by later to answer any questions you might have.

[The biographical sketch and prepared statement of Mr. Richards follows:]

BIOGRAPHY

ROBERT B. RICHARDS

Dr. Richards is General Manager, Advanced Reactor Systems Department, Sunnyvale, California

He joined the Research Laboratory of General Electric in 1947 and later that year transferred to the Hanford Atomic Laboratory where he served in a variety of managerial positions. He transferred to the Atomic Power Equipment Department, San Jose, California in 1957 and was appointed Manager, Engineering, and served in that capacity until January 1968 when he was appointed Manager, Engineering of the Reactor Fuels and Reprocessing Department. In October 1971, he was appointed Manager, Special Fuel Programs,with overseas licensing responsibilities for the Nuclear Energy Division. Dr. Richards was appointed Manager, International Business Development, Overseas Projects Department in January 1973. He assumed his present position in 1974.

Dr. Richards was graduated from Pennsylvania State University with a B.S. in chemical engineering and an M.S. and Ph.D. in organic chemistry. He is a member of the National Academy of Engineering, Fellow ANS, Fellow AIChe, R.E. Wilson Award in Chemical Engineering in 1970, and is a Professional Engineer in the state of California.

PREPARED STATEMENT OF ROBERT B. RICHARDS, GENERAL MANAGER, ADVANCED REACTOR SYSTEMS DEPARTMENT, ENERGY SYSTEMS AND TECHNOLOGY DIVISION, GENERAL ELECTRIC CO.

My name is Robert B. Richards. I am General Manager of the Advanced Reactor Systems Department of the General Electric Company. The charter of the department includes responsibility for our company's activities in the field of the Liquid Metal Fast Breeder Reactor (LMFBR). We are pleased to have this opportunity to submit our views on the role of this technology in the nation's energy future.

The General Electric Company has been an active participant in the National Breeder Program since its inception in the late 1950's. We feel that our work has contributed importantly to the progress that has been realized over the years.

There is little doubt that a fast breeder program will be needed as part of a long term nuclear energy capability.

The Administration, consistent with its stated policy that government support will be provided for high-payoff, high-risk energy options, has expressed its support for a Liquid Metal Fast Breeder Reactor Program (LMFBR).

The high-payoff of the breeder technology includes its potential for extending uranium reserves for many hundreds of years. It constitutes an insurance policy for future energy security.

The slowdown in the rate of building light water reactors and the total lack of new orders has raised questions about the timing of proceeding with the LMFBR program. I will deal with this point a little later.

In recognition of this problem, the nuclear energy policy statement issued late last year by the Administration supports the need for nuclear power and addresses several of the deep seated institutional problems that have caused this slowdown and lack of orders. We in GE stand ready to work with the Administration and DOE to arrive at effective solutions to these institutional problems. As many of you on this committee know, we are working diligently to provide a modus operandi for licensing LWRs that should improve the effectiveness of the process.

The President's nuclear energy policy statement also endorsed the completion of the Clinch River project.

General Electric has consistently supported the need for a demonstration plant - such as Clinch River - if an LMFBR program is to be successful. All countries active in breeder development have felt this step to be essential. We should also remember that the evolution of light water technology involved the equivalent of many "demonstration plants" on its way to commercialization.

Transition to private industry of the LMFBR program - while many years away - would require the government program to be carried to the point that industry collectively can accept the risk involved in building the next larger scale plant.

Such a follow-on government program should include detail plant design, supporting component development, fuel cycle development, and safety and licensing studies. Carried to the proper level of detail, such a program could provide industry confidence in costs and engineering risks and permit an eventual decision concerning industry acceptance of a commercial type venture.

We mentioned earlier the impact of light water reactor slowdown on the schedule for LMFBR development.

Because of the uncertainty in the needed timing of LMFBR commercial scale plants, the pace of the government's development program should relate to growth rate of the light water nuclear industry and the projected need for the LMFBR.

We urge that the Department of Energy, working with the utility industry and the reactor manufacturers, develop the proper pace for this follow-on government program. This will not be an easy planning activity but it should be possible to build flexibility into the program to adjust the pace as the program proceeds and progress is made in the rejuvenation of the light water reactor industry.

General Electric has in the past, and will in the future, make its resources available to carry out the federally supported LMFBR development program and will participate in the industry to follow if it becomes an acceptable business risk.

We appreciate your kind attention to our views on the LMFBR program and stand ready to answer any questions you may have.

Mrs. BOUQUARD. Thank you very much, Mr. Richards. It is always a pleasure to have you before our committee. Mr. Yasinsky, you may proceed.

Mr. YASINSKY. Madam Chairman, thank you, and good afternoon. It is my pleasure to wrap up the initial comments of this panel.

I am John B. Yasinsky, general manager of the Westinghouse advance power systems divisions. We have been for a number of years involved in the development of many advanced energy technologies including the breeder reactor. We play a lead role in the Clinch River breeder reactor plant project as well as the large plant studies that have been underway for several years.

Through the Westinghouse Hanford Co., we operate the Hanford Engineering Development Laboratory for the U.S. Department of Energy. This includes responsibility for the operation of the fast flux test facility.

Madam Chairman, I would like to comment that over the past year, the FFTF has had significant good operating experience. We are now within 1 month of starting up the first initial irradiation cycle with 59 experiments in the core and we are ready to successful move forward. It has been a very good program to date. Significant benefits from the FFTF lie ahead.

At this time, when there is a broad consensus that Federal spending be reduced, certainly the limited funds available for advanced energy technology must be used prudently. Short-range economic evaluations cannot, however, be the sole basis for near-term decisions affecting future energy supplies. There are inherently large uncertainties over the availability of fuel and the advanced energy technologies that can be available over the next two to three decades.

Accordingly, the United States must pursue a supply strategy that provides for a mix of energy sources. Not only the breeder but every viable energy technology with potential for the future should be evaluated objectively based on its merits.

Prudence dictates that R. & D. priority, however, be given to those technologies with high potential for commercial success and those which can supply large quantities of useful energy for long periods of time when they may be needed.

Electricity is a reliable energy source today. It is generated by a variety of fuels and serving multiple end-uses. Electricity's already substantial role must be increased to reduce our dangerous dependence on foreign oil. Electrical substitution has been taking place and will continue to take place.

Coal is expected to contribute about 55 percent of our electricity needs by the end of this century, but there are potentially serious obstacles to achieving this objective. We need this contribution of coal, but some of these concerns as expressed by the National Academy of Sciences are on the environmental effects of acid rain and atmospheric carbon dioxide. These are problems that can be solved, but at this point we don't know by when or at what cost. Thus, nuclear power may be required to fill a substantially larger role in the future than is currently planned.

The strong commitment of the world's industrialized countries to nuclear power, both light water reactors and breeders, indicates that nuclear power's potential to fill such an expanded role is quite high. On the basis that the light water reactor technology has reached commercial maturity and that nuclear fusion is still in the early stages of engineering feasibility, we believe that the administration's fiscal year 1983 budget request on breeder programs with emphasis on Clinch River is strategically sound.

Successful breeder demonstration should carry technology to the point of commercial readiness by the time that technology is needed. This effort is estimated to involve at least two decades, as was the case with light water reactors.

The conditions making the breeder economically competitive could exist soon after the turn of the century. This period of time provides then for an orderly program to insure utility users and nuclear suppliers that the breeder is available in a reliable and an economic form.

If demonstration is canceled now under the expectation of a later restart, it will not be available by the time it is needed, and when it is available under those conditions, its cost will be much greater than it otherwise would be.

I will not comment on the status of Clinch River with regard to the completion of the project. That has been adequately handled, I believe, by our other speakers and by the film shown earlier.

Some people have claimed that the Clinch River plant is outmoded. Again, the film went through many of the advanced technological aspects of the Clinch River Breeder Reactor Plant. I will not go into those.

Now, the broad flexibility of this reactor also provides an ideal opportunity to demonstrate the practicality of various fuel cycles that may be of interest in the future. Its size is an appropriate scale up from FFTF. It represents a prudent balance of risk, cost, and schedule.

While there will always be design improvements that could be made and alternate concepts that may be considered, we can say today that the Clinch River breeder reactor plant is modern, conservatively designed, and clearly responsive to the demonstration plant objectives. Most particularly, the components are up to date and would be the basis for any to be used in follow-on larger plants.

To borrow the rhetoric of project opponents who in the past have called Clinch River a "technological turkey," Madam Chairman, I believe that it is just the opposite. Clinch River is an American eagle, a valuable domestic resource in danger of extinction.

Further delay in the project schedule could terminate continued industry participation in breeder development and undermine vital electrical utility confidence in the commercial potential of this very important future energy resource. Therefore, we believe strongly that program funding allowing for rapid construction is in the national interest.

The breeder base technology program has provided vital input to the design of the FFTF and the Clinch River plant. At this time, most of the R. & D. in support of Clinch River is completed. The scope of ongoing efforts should be reoriented toward the next plant in the demonstration phase. Technology programs should be increasingly focused on the specific programmatic need as identified by the operation of FFTF, the completion of the design and construction of Clinch River, and in the development of key components which will be needed in the future for all sizes of breeders. In this manner, the design of a commercial breeder can proceed in the future on a sound and cost effective technological basis.

It is anticipated that the scope of the breeder base program will change substantially as construction and operating experience accumulates. New programs will be established to resolve unexpected problems, and ongoing programs must be phased out as their objectives are completed. However, continued adequate funding for essential base technology programs is needed to assure the health of the U.S. breeder reactor program. It also directly impacts the well-being of the Hanford Engineering Development Laboratory whose direction as a mission-oriented laboratory primarily focused on breeder fuel and materials development was selected, developed, and performed at the request of the Government. Ninety-two percent of this lab's funding is in the breeder area.

Since January 1981, manpower at this laboratory in Washington State has been reduced by about 600 people, including a 243-person layoff last November. Projections for fiscal year 1983 are more severe and will result in an even greater manpower reduction for this breeder technology mission-oriented laboratory.

The key focus at the Hanford Engineering Development Lab is breeder fuels and materials. We have come a long way, but we still must prove through FFTF and its supporting facilities that we can come up with the high-burnup fuel that is needed for better breeding capability, lower fuel costs, and the kind of overall economic costs that will be essential for the success of this program.

Industry and utility confidence in the breeder's commercial viability cannot be derived from the intermediate size Clinch River plant alone. Additional construction and operating experience from at least one commercial sized plant will be necessary. Furthermore, we believe that a follow-on to Clinch River is essential to preserve the core of the national breeder design team that has been built up over many years and that has made many major contributions to our overall program.

We believe that the private sector will be willing eventually in the future to assume a larger role in the management of the next breeder demonstration project based on what is now called the large developmental plant.

Accordingly, we recommend that the Federal Government provide interim financial support to a large developmental plant project to the extent that at least a core of the existing U.S. design team can be kept intact to develop the conceptual design for a large breeder reactor powerplant.

This Nation's unique analytical and experimental resources were largely responsible for the successful movement of the U.S. breeder program through the basic R. & D. and test stages to the demonstration phase which is now upon us.

Demonstration necessarily involves the construction and operation of economic, safe, and efficient powerplants utilizing the expertise and experience found primarily in the industrial sector.

We believe that carrying out the LMFBR demonstration phase will necessitate a substantial future shift in funds from the largely completed R. & D. program to the design, fabrication, and construction of plant component systems and facilities.

However, this must be done while maintaining essential mission-oriented support technology development and testing. Stopgap measures are now in place to supply some follow fuel for FFTF and future fuel for Clinch River. However, over the long term, nuclear fuel reprocessing capabilities must be developed to enable complete utilization of our domestic uranium resources, both in light water reactors and most crucially in the liquid metal fast breeder reactors.

Westinghouse strongly supports closing the nuclear fuel cycle, including reprocessing, so that Americans can fully benefit from the energy nuclear power can provide.

Madam Chairman and members of the subcommittee, thank you for the opportunity to express our views on this most important issue.

[The biographical sketch and prepared statement of Mr. Yasinsky follows:]

DR. JOHN B. YASINSKY
WESTINGHOUSE ELECTRIC CORPORATION

Dr. John B. Yasinsky is General Manager of the Advanced Power Systems Divisions of the Westinghouse Electric Corporation. Joining the corporation in 1963, Dr. Yasinsky was assigned to the Bettis Atomic Power Laboratory, working in reactor theory, design, dynamics and control in support of the naval nuclear program. In 1971 he was named manager of electric systems and plant analysis at Bettis.

The following year John was named to the White House Fellows Program and served as Special Assistant to the U.S. Secretary of Commerce.

Returning to Westinghouse, Dr. Yasinsky was named Manager, Business Development for the Breeder Reactor Divisions, moving through a variety of marketing management jobs. In 1978 he was appointed Director of the Advanced Coal Conversion Department which was responsible for the firm's activities in low and medium BTU coal gasification research and development.

Appointed President of Westinghouse Hanford Company in January 1979 he was responsible for the operation of the Hanford Engineering Development Laboratory for the U.S. Department of Energy. A major responsibility there is also the operation of the Fast Flux Test Facility for testing breeder fuels and materials. Work is also underway on developing and testing materials for fusion reactors.

He was appointed to his present position in August of 1980. In this post he is responsible for the Advanced Reactors Division, the Westinghouse Hanford Company and the Advanced Energy Systems Division.

Dr. Yasinsky received his B.S. in physics from Wheeling College. He earned a master of science degree in physics from the University of Pittsburgh and his Ph.D. in nuclear science from Carnegie Institute of Technology (now Carnegie-Mellon University). He has authored numerous technical papers and reports and taught in the graduate programs at Pittsburgh and Carnegie Mellon.

Dr. Yasinsky is a member of the American Nuclear Society, the National Security Industrial Association and has served on the Advisory Council of the National Energy Resources Organization. He is a member of the White House Fellows Association.

STATEMENT OF DR. JOHN B. YASINSKY
WESTINGHOUSE ELECTRIC CORPORATION
BEFORE THE
U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

MARCH 10, 1982

MADAME CHAIRMAN,

I am John Yasinsky, General Manager of the Advanced Power Systems Divisions of Westinghouse Electric Corporation. Our company is involved in the development of a broad spectrum of advanced energy technologies, including the breeder reactor. Through our Advanced Reactors Division , we play a lead role in the Clinch River Breeder Reactor Project, and Large Plant studies. Through the Westinghouse Hanford Company, we operate the Hanford Engineering Development Laboratory for D.O.E., including responsibility for the Fast Flux Test Facility.

At this particular time, when there is a broad consensus that a reduction in federal spending is necessary for restoring fiscal order to our national economy, the limited government funds available for the development of advanced energy technologies must be used prudently.

Nevertheless, short range economic evaluations cannot be the sole basis for near-term decisions affecting our future energy supplies because there are inherently large uncertainties associated with the availability and competitive position of primary fuels and advanced energy technologies over a period of 2-3 decades. A national energy policy that depends heavily on economic projections, major discoveries of domestic energy resources and/or technological breakthroughs entails substantial risk that our country will not have an adequate and reliable supply of energy in the future. Accordingly, the U.S. must pursue a supply strategy that provides for a mix of energy sources which will permit our various consumption sectors to accommodate a broad range of political, economic and technological developments.

Prudence dictates that R&D priority be given to those technologies whose potential for commercial success is high and which can supply large quantities of energy in a useful form when needed.

ELECTRICITY/NUCLEAR/BREEDER

Electricity is a reliable energy source, generated by a variety of fuels and serving multiple end-uses, that should be given a central role in the U.S. energy supply strategy for the future. Electricity already has a substantial part in supplying the U.S. energy needs but must be used more extensively to reduce our dangerous dependence on foreign oil.

Coal is expected to contribute about 55% of our electricity needs at the end of this century, but there are potentially serious obstacles to realizing this vital objective, including the concerns of the National Academy of Sciences on the regional and global environmental effects of acid rain and atmospheric carbon dioxide from coal combustion. Thus, it is not unlikely that nuclear power may be required to fill a substantially larger supply role than currently planned.

The light water reactor (LWR) will continue to be an economic source of nuclear power at the turn of the century. The LWR and the LMFBR will complement, rather than compete with, each other as market conditions justify commercial deployment of the LMFBR and during the gradual transition to a breeder economy. Factors which will determine the competitiveness of the LMFBR with respect to the LWR and commercial non-nuclear power plants contain inherently large uncertainties and cloud the exact date when the LMFBR will be economically attractive. One of these factors is the future supply and demand for uranium which can rapidly become unbalanced in the event of resource/production constraints on uranium ore or shortfalls in the availability/utilization of fossil fuels. Despite a few plant cancellations, sufficient LWRs will be operating to deplete the available low cost uranium. It is quite plausible that these factors will act collectively to make the LMFBR competitive near the turn of the century, at which time its contribution to vital U.S. energy supplies would increase rapidly to support the economy, stabilize electricity prices, and justify the government's past investment in LMFBR development. The strong commitment of the world's industrialized countries to development of the LMFBR and the substantial progress made to date by these foreign programs indicate that the potential of the fast breeder to fill such a role is quite high.

On the basis that LWR technology has reached commercial maturity and that nuclear fusion is still in the early stages of engineering feasibility, we believe that the emphasis in the Administration's FY-83 budget request on the LMFBR program is technically and strategically sound.

CRBRP STATUS/SCHEDULE

The incentive for proceeding with LMFBR demonstration in the U.S. is not to replace the LWR with an economically superior design over the near term, but to carry LMFBR technology to the point of commercial readiness when it will be needed. The demonstration effort required to bring the LMFBR to commercial status is estimated to involve an elapsed time of approximately two decades, as was the case with LWRs. The economic conditions required to make the LMFBR competitive with other electric generating plants are expected to exist soon after the turn of the century. This is the earliest time that an orderly LMFBR demonstration program can provide the necessary assurance to the utility users and the nuclear suppliers that the LMFBR is a safe, reliable and economic source of electric power. If the LMFBR demonstration program is cancelled now under the expectation of a restart when it is competitive, it will not be available when needed.

Design of the CRBR demonstration plant is almost 90% complete and 25 major components, prototypes and test items, valued at $250 million, have already been delivered. Another $380 million in components have been ordered and are in various stages of completion. Prompt initiation of CRBR construction-related activities at the Clinch River site would permit plant start-up in 1988. The recent vote by the three Carter Administration holdovers on the NRC against early site clearance authorization will prove expensive for the taxpayers and should be reversed as soon as possible. If the CRBR project were terminated and replaced by a new plant project, it is estimated that at least 10 years would elapse before a new project organization could be established and before the design/procurement effort could reach the current status of the CRBR project.

Some have claimed that the Clinch River plant is outmoded. In fact, the truth is that CRBR design, both system and components, benefits from the most current knowledge and experience, and incorporates the latest U.S. and foreign technological advances. CRBR also includes several unique design achievements not found in foreign plants; for example, CRBR has an advanced core arrangement called the heterogeneous core, in which foreign developers are keenly interested.

The broad flexibility of the reactor provides an ideal opportunity to demonstrate the practicality of fuel cycles. Its size is an appropriate scale-up from the recently completed FFTF test reactor and represents a prudent balance of risk, cost and schedule. While there will always be design improvements that could be made and alternate concepts that also merit development and demonstration, the Clinch River Breeder Reactor is modern, conservatively designed and clearly responsive to LMFBR demonstration plant objectives. Most particularly, the components are up-to-date and would be the basis for any to be used in larger plants.

To borrow the rhetoric of project opponents who have called Clinch River a "technological turkey," it is just the opposite - an American Eagle - a valuable domestic resource in danger of extinction.

On the basis that further delay in the CRBR schedule would virtually terminate continued industry participation in LMFBR development and undermine vital electric utility confidence in the commercial potential of the fast breeder, we believe that program funding that allows the CRBR to proceed rapidly to construction is in the national interest.

LMFBR BASE TECHNOLOGY PROGRAM

The LMFBR Base Technology Program being conducted by numerous government and industrial organizations has provided vital input to the design of FFTF and CRBR. At this time, 90% of the research and development in support of CRBR is completed and the scope of ongoing base program efforts should be reoriented towards the next plant in the demonstration phase. Breeder technology programs should be increasingly focused on specific problem areas identified during the operation of FFTF and construction of CRBR, and on the development of the key components which will be needed in all sizes of breeders. In this manner, the design of a commercial LMFBR can proceed on a sound and cost-effective technological base.

It is anticipated that the scope of the Base Technology Program will undergo substantial change as construction and operating experience accumulates on the various reactor projects. New programs will be established to resolve unexpected problems and ongoing programs will be phased out as their objectives are achieved. Based on the current status of LMFBR development in the U.S., the technology areas that we believe should be emphasized by the LMFBR base program are as follows:

- The safety program should focus on enhancing the reliability of the reactor-shutdown and shutdown-heat-removal systems and the safe accommodation of faults that might occur in the reactor shutdown system.

- Operating experience with LMFBR demonstration plants in the U.K. and the U.S.S.R. indicate that the steam generator has been the weak link in achieving high availability in an LMFBR power plant. Accordingly, the current U.S. strategy of developing three steam generator designs, one of which utilizes double-walled tubes to achieve extremely high reliability, is considered to be a prudent strategy that should be retained in the base LMFBR program in spite of its higher cost.

- The construction of test facilities to support the program should continue with FMEF required in support of the FFTF irradiation program and upgrading of ETEC capability for testing reactor components. It is anticipated that no new facilities will be required to meet program objectives and that phase-out of existing facilities will gradually take place as plant operating data accumulate and as each test facility completes its basic mission.

Continued adequate funding for these base technology programs is needed to assure the health of U.S. breeder development. It also directly impacts the well being of the Hanford Engineering Development Laboratory (HEDL).

HEDL's orientation as a mission oriented facility primarily focused on breeder fuel and materials development was selected, developed and performed at the request of the government. Ninety-two percent of its funding is in the breeder area; about five percent is in HEDL's recent initial activities in fusion programs.

1982 budget actions resulted in the layoff of 243 personnel there; projections for 1983 are more severe and could be twice as large, if not greater. Unlike other government laboratories, HEDL does not possess a broad diversity of programs to ameliorate reductions in breeder and fusion programs, and is therefore severely penalized for having structured its operations as requested by the government.

Moreover, programs being deferred, delayed or terminated are of key importance to the successful development of breeder and fusion systems. At stake are not just a few jobs today, but potentially many thousands of jobs tomorrow. The work being done today will make it possible to have breeder reactors and fusion power systems in the future. Regretfully, retarding these programs now because we don't need them yet is a classic example of what Benjamin Franklin called penny-wise and pound-foolish.

LARGE DEVELOPMENTAL PLANT

Industry and utility confidence in the commercial viability of the LMFBR and their ability to make substantial financial commitments to the LMFBR cannot be derived from the intermediate-size CRBR alone. Additional construction and operating experience from at least one commercial-size plant will be necessary to achieve this level of support.

Furthermore, we believe that a follow-on to the CRBR is essential to preserve the core of a national LMFBR design team that was built up over an extended period of time and that has made major contributions to LMFBR technology.

We believe that the electric utility industry is able and willing to eventually assume a larger role in the management of the next LMFBR demonstration project - the Large Developmental Plant. However, the financially troubled utilities need additional time to accumulate the technical and capital resources required for this purpose. Accordingly, we recommend that the federal government provide interim financial support to a Large Developmental Project to the extent that at least a core of the existing U.S. design team can be kept intact for the useful purpose of developing a conceptual design for a large LMFBR power plant.

LMFBR FUNDING DISTRIBUTION

The development of the LMFBR into a commercially viable technology involves successful progress through a series of developmental phases. Starting from basic research that established the scientific feasibility of nuclear breeding, the U.S. LMFBR program then proceeded to verifying engineering viability by intensive and extensive investigations of specific technology areas comprising the LMFBR system. The unique analytical and experimental resources of the national laboratories were largely responsible for successfully moving the U.S. LMFBR program through these two phases to the demonstration phase that is now upon us.

Demonstration necessarily involves the contruction and operation of economic, safe and efficient power plants which involve the expertise and experience found primarily in the industry sector. Accordingly, we believe that the most efficient use of national resources in carrying out the LMFBR demonstration phase will necessitate a substantial shift in funds from the largely completed R&D programs of the national laboratories to the design, fabrication and construction of plant components, systems and facilities that can best be performed by private industry.

LWR/LMFBR FUEL REPROCESSING

In the absence of a national capability to recover plutonium from LWR spent fuel, the government had previously supplied low-burnup plutonium from its stockpile for the early cores of the FFTF project. This action circumvented the need for fuel reprocessing and allowed fuel fabrication to be safely accomplished without radiation shielding in existing industrial facilities. These private facilities have since been decommissioned and current government inventories of separated plutonium available to the U.S. LMFBR program are inadequate to satisfy the fuel needs of plant projects beyond FFTF. However, a limited quantity of unseparated plutonium available from the federal government would probably satisfy the fuel requirements of the initial CRBR core. Furthermore, an additional quantity of low-burnup LWR spent fuel that contains enough unseparated plutonium for 4-5 CRBR replacement cores is currently stored at a number of commercial power plant sites.

The initial use of low-burnup plutonium as a reactor fuel detracts somewhat from breeding performance, but is a necessary expedient to ensure that the CRBR project is not delayed for lack of fuel. Therefore, the LMFBR fuel cycle program must initially focus on measures to implement this near-term fuel supply strategy and then take appropriate steps to extract plutonium from high-burnup LWR spent fuel. Over the long-term, the program must develop any special technologies required for the reprocessing of breeder spent fuel.

The relatively slow accumulation of breeder spent fuel from the demonstration plants and the long-range timetable for establishing a commercial breeder fuel cycle suggest that demonstration of breeder fuel reprocessing will not be needed before the late 1990s.

Mrs. **Bouquard**. Thank you very much, Dr. Yasinsky. That is very fine testimony from all of you gentlemen.

Last week when Secretary Edwards appeared before the full committee in response to the subject questions, there was some discussion of electrical power requirements that would not be needed.

Mr. Kearney, would you extend somewhat on your projections on the expected growth in the electrical power requirements over the next decade and the role which you see nuclear power playing in meeting this expected demand?

Mr. **Kearney**. I would be pleased to do so, Madam Chairman. What I would like to do is refer to a report of the Edison Electrical Institute called Economic Growth in the Future. I would not suggest putting it in the record, but I would be pleased to make a copy available to the subcommittee for whatever use you may make of it.

Mrs. **Bouquard**. We certainly would be happy to have a copy of that.

Mr. **Kearney**. I think the prime conclusion of this report—which was first of all done with the aid and assistance of many academicians and experts in the energy field—is that energy growth in the future, or lack of it, is a choice, not necessarily a chance.

In other words, if the country believes, as I am sure most of us do, that we would like to see economic growth for the benefit of the citizens of the United States, there are things that we can do in order to assure that happens.

With that in mind, we went through several scenarios. I will just refer to one of them which is called the preferred scenario, which is the one which has as its basis that we have an opportunity to choose our future and not haphazardly get into our future.

One of the things that is apparent from this study is that there is going to be a greater penetration of electricity in the energy spectrum in the future. It seems to be the energy of choice. It is clean at the point of use. It can be used in large quantities and small quantities. It can be controlled. It can do almost anything. It can't fly an airplane. I am not so sure that we will ever see that day. However, there are many other things that it can do.

Second, based on the study, it would appear that the price of all energy is going up, but the price of electricity is probably not going up as fast as the price of world oil or natural gas after 1985, that magic year when it will be decontrolled.

One of the reasons for that is the fact that we can rely on nuclear energy as a fuel for the production of electricity.

Now, let's go to some numbers. We feel that this study shows that probably in the year 2000 as far as the total energy input or energy use is concerned, it will be about 117 quads. In making that judgment, we identified or considered what we called productive savings, and that energy growth would probably be about 13 quads higher if it were not for the fact that there will be conservation and more efficient use of energy.

Therefore, I think one of the first points to make is that, we are taking into consideration what can be done by conserving energy and by using it more effectively.

With all of that in mind, we see a generation growth—a growth in electric generation—of approximately 4.3 percent. That would go along with the GNP growth of 3.1 percent. Most of that in the year 2000, about 54 percent of that energy would be generated from coal and about 33 percent would be generated by nuclear. Therefore, we do see an increase in the amount of nuclear that is being used, and it would be very necessary to meet these objectives in the future.

Mrs. BOUQUARD. Mr. Kearney, EIA recently published a report, and I think they projected growth at about 2.7 percent. Do you disagree with the figure?

Mr. KEARNEY. Well, you know, it depends upon where we are and what happens as far as policy is concerned in this country. We can see growth anywhere from 2 percent to 5.4 percent. I have given you what I have said was the preferred scenario.

However, with other scenarios, obviously, they will either be less or greater growth.

I would like to give you one additional figure. If you take that lower growth of electricity—say 2 percent—which would go with the GNP growth of 1.7 percent and put that into perspective, with the last decade which was certainly the decade of lower growth, the growth was 2.9 percent.

However, if you take 1.7 percent GNP growth which goes with 2 percent electricity growth, by the year 2000, we would need an additional 215,000 megawatts of electrical power in addition to the capacity that is already ordered to meet that growth and take into account the retirements of capacity in older plants which no longer can be maintained or considered reliable.

Therefore, no matter what scenario you pick, in our judgment, there is going to be growth in electricity, and there is going to be need for additional generating capacity.

Mrs. BOUQUARD. Thank you very much. Well done. Dr. Richards, I think I am going to be a little bit redundant. I am going to go back to a subject that you talked about which is industry's role as well as the Federal Government's role.

In the description of the breeder reactor assistance program, the budget document states that the immediate goal of the LMFBR program is to develop the technology to a level where industry can make the appropriate commercialization decisions under circumstances of acceptable commercial risks.

What formal procedures are in place or planned to make the judgments as to when such risks become commercially acceptable for a particular technology? In other words, what are the agreements between Government and industry, if any, which relate to this matter.

I think what I am asking is what level of government participation is required and what constitutes conditions of acceptable risk?

Mr. RICHARDS. I believe that, of course, the utility industry itself should comment on your question, but I would be happy to give you our views.

Mrs. BOUQUARD. Well, I asked you that. I was going to ask Mr. Dubrow that question also.

Mr. RICHARDS. Yes. We, along with others, of course, are presently involved with the Department of Energy in working on a program looking at a design of a large commercial size breeder which is labeled the LDP program.

We have said many times in previous testimony that a very essential ingredient of the national breeder program should be the continuing effort in the advanced design of a commercial sized plant.

There are a number of reasons for this. One is to take advantage of the things that we are learning from the base technology program, to take advantage of the things that we are going to be learning from the Clinch River reactor to be able to make these advancements and be able to do such a program in such a level of detail—design work, the component development work, the fuel cycle work—that we could assemble over a period of some years a body of technology that the utility industry and the manufacturers could sit down and say, "This level of detail now satisfies us with respect to our ability to judge the costs, the risks, and we are now satisfied that we can undertake such a project sometime in the future."

We think that there would not be a complete transition to the private sector with the private sector taking such risks until such a program as I have described were carried out. We have made this recommendation to the Department of Energy. We have had conversations with EPRI, to let the utility industry know that those are also our views. However, we cannot speak entirely for the utility industry. We are just making a recommendation in our judgment as to what it would take to get the private sector convinced that they now have a body of technology that they can move on and start applying commercially.

Mrs. **Bouquard**. Thank you. When I spoke of industry, I was really referring to the manufacturers as well as the utilities.

Mr. **Richards**. Sure.

Mrs. **Bouquard**. Mr. Dubrow, would you care to comment?

Mr. **Dubrow**. Well, our loads have been growing up until this year, and even this year they have been growing at a more rapid rate than the overall loads in the country. This year our load stands at about 1 percent. Last year it was 3. The year before, we had 7.

We expect that there will be increased demands for electricity in the country. In order to satisfy those demands, we have this dream, if you will, that we will get energy at a stabilized price like we had it up into the mid-1960's. In order to do that, we need nuclear power, and we need the breeder program because that is the only way that I can see and that our people can see that we can get an assured fixed price for electricity because the fuel costs will be fixed.

If you put in a coal plant today and it costs $50 million for the plant, you can just assume that there is another $25 million for the fuel, and that is escalating as the cost of oil and gas goes up. Therefore, we are convinced that the kind of clean, environmentally acceptable electricity that this country needs and that our people need can only be achieved by continuing to exploit and use nuclear power and by all means by building the breeder reactor.

Mrs. **Bouquard**. Thank you very much.

Mr. Kearney.

Mr. **Kearney**. I think it was probably implicit in what Dr. Richards said, but maybe I should make it explicit for the record.

When we talk about what risks to take, one of the things that is going to be very important to the electric utility industry is the risk or lack thereof in the licensing process.

Therefore, I think we will want to see a process that is stable and certain as far as the breeder is concerned when we consider the commercial breeder, just as we like to see it with light water reactors.

The other thing is experience in the maintenance and operation of a plant. I think that all of these things are going to be helped by the Clinch River Breeder Reactor; however, there is going to have to be something done beyond that to decrease this risk.

Mrs. **Bouquard**. Thank you very much.

Dr. Yasinsky?

Mr. **Yasinsky**. I would like to add a few minor points along the lines of the point made by Mr. Kearney.

Mrs. **Bouquard**. Yes.

Mr. **Yasinsky**. One of the major problems that we face, not only today on this program but for the last decade on many large developmental programs, is the lack of continuity in governmental policy, not just in the ability to license. Where we have had to start major programs and stop certain portions of those programs, we basically retard the development as well as increase the cost of those programs. That prevents us from getting to the point where we can get the kind of operational experience that will be required.

Certainly, without completion and operation of Clinch River, we cannot move on to a larger plant. No country in the world has taken a scale-up from a FFTF size plant to a 1,000-megawatt plant. This includes not only fast breeder reactors but for any nuclear powerplant. That intermediate scale-up is essential.

It is my belief with the continued progress, construction, and operation of Clinch River, we will have under our belts the kind of experience that will permit along with continued, albeit maybe decreasing, Department of Energy funds, the environment for the private sector to make an attempt to play a larger role in a follow-on plant program.

There are many ifs and many uncertainties. However, certainly, if that goes forward, it will have to be a collective effort involving the utilities, reactor manufacturers, and the kind of off-budget support that the Government might be able to provide.

Certainly, if we take a look at the breeder or any other promising energy technology where the benefits may not be achievable until after the turn of the century, there is no one firm in this country that can fund that kind of investment.

I think a simple example puts this concept in better perspective: Given the cost of money for a commercial firm for a R. & D. type program that involves this kind of risk, requires that for every $1 we invest today, we must have profits—not sales—of $30 in the year 2000 to simply break even.

What that says is for programs that involve tens or hundreds of millions of dollars or more and where the benefits accrue several decades out—and these are generally benefits to the Nation as a whole rather than one firm—it is not appropriate and will not be possible for any one firm to carry that burden.

Mrs. **Bouquard**. Thank you very much.

Mr. Volkmer?

Mr. **Volkmer**. We had testimony yesterday on the Clinch River project. They want to move ahead at a faster pace, but to be honest with you, some of us see the total budget being reduced all down the line.

Do you envision any problems in the event of, not a faster pace, but a normal pace or maybe even slower on Clinch River?

Anyone can answer.

Mr. **Yasinsky**. I would like to comment first on that. Clinch River was a project that was started in 1972. It is a project which, as we are all aware, has had significant increases in the estimated cost of completion. Since the base design was set in 1974, 80 percent of that increase in cost is attributable to external sources: licensing delays, delays due to inadequate funding, but mostly the over $800 million increase in the cost estimate to complete is due to the delays imposed over the 4 years of the preceding administration.

The point I would like to make is that if we delay, we end up costing the Government and the taxpayers more money to achieve the same benefit. Since we today have the organization in place, 80 percent of the major components on order and $250 million worth of them complete, the team is ready to start construction; the cost-effective thing for this country to do is to get on now and complete the project and to achieve the benefits.

If we slow it down, sir, we increase the costs. We don't increase the benefits.

Mr. **Volkmer**. Well, I realize that it will increase the cost in the long run. It may decrease the cost next year. That is what I am saying.

Mr. **Yasinsky**. I would agree. If you decrease the funding next year, it will save; however, I think it is important that those who are charged with defining this overall program be very, very sensitive to the total costs in the future.

I think the predicaments we find ourselves in today could have been mitigated if there was greater concern given to the future cost of the programs when they were debated in the past.

Mr. **Volkmer**. What is the total utility participation at this time in money?

Mr. **Kearney**. The electric utility industry, as we said in our testimony, has pledged $253 million to the project. Of that amount of money, approximately $100 to $125 million has been provided to the project up to this time.

Mr. **Volkmer**. And can the utilities provide any additional funds?

Mr. **Kearney**. I take it, sir, you mean beyond the $253 million that has been pledged?

Mr. **Volkmer**. Yes.

Mr. **Kearney**. I think that would be very difficult for the electric utility industry at this moment for two reasons. No. 1, as you may or may not know, the industry is having financing difficulties with its own programs to develop generation for its customers at this moment. This problem results from a high rate of inflation and high interest cost which both impact very strongly on a capital intensive industry.

The second thing has been pointed out already. It is the uncertainty of the manner in which the Government cooperates in these projects that makes it very difficult for management to go to its board, its stockholders, and also its customers to put more money into this type of project.

However, primarily, it is because of the financing difficulties of the industry which, I think, prohibit the industry from making additional contributions at this time.

Mr. **Volkmer**. When do you envision that the project will be completed? When will Clinch River be completed and will start up testing, if you are fully funded as provided in here for the subsequent years?

Mr. **Yasinsky**. If the funding is provided fully as required by the budget, then the initial criticality date would be in late 1988 or late 1989.

The late 1989 date would be the completion date, assuming progress through the standard construction, licensing approach and getting a limited work authorization.

Had the situation evolved, or if the situation would evolve, such that we are able to begin the preliminary site work, then we feel that could provide completion approximately 1 year earlier.

Mr. **Volkmer**. How many years of test are there? How many years will it take to test it out, prove it out, before you can design an operational breeder reactor of the size sufficient enough to warrant commercialization?

Mr. **Yasinsky**. The currently defined demonstration period——

Mr. **Volkmer**. Yes.

Mr. **Yasinsky** [continuing]. Is 5 years.

Mr. **Volkmer**. And where are we going to get the money to build the commercial plant?

Mr. **Yasinsky**. I think, as we discussed before, a follow on, precommercial type plant would have to involve participation of the private sector with, hopefully, some Government support that might be in the form of off-budget support. It would have to be an effort involving the private sector with appropriate Government support.

We are not in a position today, certainly, to start that. It is premature as far as timing is concerned.

Mr. **Volkmer**. Oh, I agree.

Mr. **Yasinsky**. It is a major challenge to complete Clinch River right now, and that is where our priority lies.

Mr. **Volkmer**. Oh, I am sure that Clinch River will prove out and everything will be demonstrated to show that it can be done because it has been done elsewhere. Right?

Mr. **Yasinsky**. Breeder plants certainly have operated elsewhere, and they have operated well.

Mr. **Volkmer**. All right. However, the problem I'm getting to is, Where is all the capital funds going to come from that are going to be necessary down the road? We can't do it now. The utilities can't come up with a penny now. All of a sudden they are going to come up with a lot of money 10 or 12 years down the line?

Do you foresee utilities making a whole bunch of money? Is that what you are telling me?

Mr. **Kearney**. I would like to think that is so, but I know no one can foresee that. No one can predict——

Mr. **Volkmer**. I agree.

Mr. **Kearney**. No one can predict what the state of the economy or what the state of the financial condition of the electrical utility industry is going to be 10 or 12 years from now.

We are hopeful that both will be better—both the state of the economy and the state of the electrical utility industry.

However, I concur in what has just been said, that if one suggests that since that question is not fully decided with certainly that we shouldn't get on with the job—and I am not saying that you said that.

Mr. **Volkmer**. No. I am just trying to face reality.

Mr. **Kearney**. Well, I think the reality is that the breeder is going to be necessary for this country, and that we should take the steps that we can take right now. We should be planning for the steps that have to be taken in the future.

Mr. **Volkmer**. My problem arises from the fact—and I have spoken of this earlier in this committee and in the full committee when the Secretary was here—under the present energy total budget, we have only got so much money. That creates the problem. I do not think that you can say that it is nuclear or anything else. You know, we just do away with it and forget it. They have done that in other areas and let the private marketplace take it.

Therefore, some of us are quite upset with that. It is not to the point where we don't want to proceed with what you are trying to do. It is a question of trying to find a little room to have other things, too. Do you understand the situation?

Mr. **Kearney**. Yes.

Mr. **Volkmer**. Thank you, Madam Chairman.

Mrs. **Bouquard**. Thank you very much, Mr. Volkmer.

Mr. Lundine?

Mr. **Lundine**. I apologize for being late in arriving. I have no questions.

Mrs. **Bouquard**. We are happy that you are here. You say you have no questions?

Mr. **Lundine**. No.

Mrs. **Bouquard**. I have a question for all members of the panel. We received a copy of a letter from a high-ranking official in the French Atomic Energy Commission which indicates his support for completing the Clinch River Breeder Reactor. I will, without objection, include this letter in the record at this point.

[Material to be supplied follows:]

RÉPUBLIQUE FRANÇAISE

COMMISSARIAT A L'ÉNERGIE ATOMIQUE
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75752 PARIS CEDEX 15

APPLICATIONS INDUSTRIELLES NUCLEAIRES
LE DIRECTEUR

PARIS, LE February 12, 1982

Mr. Mark P. Mills
Scientific Representative
Director, Washington Office SE2
1225 Nineteenth Street NorthWest
Suite 415
Washington D.C. 20036

Ref 82.30

OBJET:

Dear Mr. Mills,

Thank you for your kind letter of January 27, 1982. It was for the CEA and particularly for myself a great pleasure to receive in France the Congressional staff which you accompanied.

During our meeting in Paris, we discussed in particular the place of the fast breeder reactor in nuclear energy programs, both in the United States and in France. The U.S. team asked me if, from our perspective in France, the US should build now a loop type LMFBR like the Clinch River Breeder Plant. My personal answer to this question was, as you may remember, straight forward and I am quite ready to elaborate a bit more on it in a written form.

I think it is crucial that the US remain strongly involved in fast breeder reactor development, a field in which your country made remarkable achievements in the past. My opinion is not only based on considerations related to the international perspective. Though I should not like to interfere at all with your domestic affairs,such a continuous involvement in the LMFBR R and D and demonstration seems to me equally vital in consideration of your long term national energy policy.

Therefore I think that the US should proceed in building the CRBR, if only because I do not see any viable alternative in the near future. A long lasting interruption in the construction of breeder plants would be very detrimental to maintaining in the US a strong and good expertise on fast breeders in the R and D teams and in the industry as well.

For sure the CRBR is a loop type reactor and it is equally true that since many years we have chosen - like other countries did - the pool design. We have no reason to regret or to revise such a choice, and we continue to consider the pool type as particularly attractive from several standpoints, as the excellent operation of Phenix shows. Still I think that the differences between the two systems, which have much in common and use basically the same technology, have been greatly overemphasized in the past. Anyhow, the fact that CRBR is a loop type reactor would not be in my opinion a meaningful argument to cancel or to defer it.

Sincerely,

G. VENDRYES

cc B. Barré

Mrs. BOUQUARD. I would also like to ask if any of you have any comments on this letter considering the fact—and I think this is very important—that the French are using a different design?

Mr. KEARNEY. Well, let me comment first, and maybe some of my colleagues would also like to comment.

I personally have had private conversations with the French, and they have indeed said that they felt that the United States should build the Clinch River reactor. To put it in very simple terms, they felt that we ought to have hands-on experience if we are to be able to grapple with this rather difficult, but very important technology.

As far as the fact that the Clinch River breeder reactor is of a different fundamental design than the type that the French are building, in my judgment is not any reason why we shouldn't be building the CRBR.

It is quite evident that a lot of the technology that is developed in either a pool or a loop-type reactor—and incidentally if you don't mind the pun, a loop is "pool" spelled backward—is very meaningful in both instances.

As far as the core itself—and these gentlemen on my left can speak to this in greater detail—as far as the core physics, the flow of sodium within the core, et cetera, they are just as valid an experience in one as in the other.

Really, it is just the secondary system which is fundamentally different.

Therefore, in summary, I am pleased to hear that the French have gone on record. I don't think it is the most important thing that they agree with us on this, but they are very experienced people, and I am pleased to hear that they have done this. They have gone on record to this effect, but I think the most important thing is what I have just said as far as the technology is concerned.

Mrs. BOUQUARD. Thank you very much, Mr. Kearney. Getting back to the budget—and the rest of the questions I ask to the entire panel; any of you who care to respond, feel free to do so.

I think we are all in general agreement that the breeder reactor system is essential to the revitalization of our U.S. nuclear industry. Do you believe that this budget we just received for the program is sufficient to achieve our objectives?

Do any of you have any comments on the budget for this year—the fiscal year 1983 budget?

Mr. KEARNEY. Well, let me try. We are very pleased to see that there is an increase in the Clinch River breeder reactor funds. There has been a decrease, as you know, in the overall base program. Given the fact that we are probably 4 or 5 years behind our original schedule, I certainly do not think that the funds are necessarily adequate. However, considering all the other impositions on the budget, I would probably classify it as marginally acceptable.

Mr. YASINSKY. Madam Chairman, I would like to comment along the same lines. Basically, I do feel that we have fallen behind. Certainly, to the degree that we can speed the program up, we can save money overall.

However, I do respect very much the fact that there have been cuts in other programs. As I indicated in my formal testimony that I provided earlier, it is my belief that each viable energy technology should be evaluated on its own merits and evaluated objectively.

I would hope that we would not run into a situation where we have one technology having to have its funding significantly decreased to provide for others. I would hope that the debate can evaluate each technology on its own merits because certainly we will need a mix of technologies in the future. I think we are poised now to move forward.

As to our breeder program moving forward, certainly, we would like to have more. I think it is marginal. I think it will be a budget that can begin to move us back in the direction I would like to see us going. I believe it is a challenge to us who are responsible for the various parts of the program, now, to move forward and efficiently complete the tasks that have been assigned to us.

Mrs. **Bouquard**. How concerned are you about the fact that we have fallen behind Japan and France and Russia in developing our technology?

Mr. **Yasinsky**. One point I would make is that the need for the breeder will vary from country to country. Certainly, countries such as Japan, where they are almost totally dependent upon imports, both oil, gas, and coal, have a need for the breeder that is probably more pressing than ours is timewise, similarly in Europe and certainly France.

Right now, Madam Chairman, I believe that we have a program which, if we are able to continue, will provide demonstrated breeder plant technology and hopefully breeder reprocessing technology by sometime close to or just beyond the turn of the century.

It is my belief that this is the time by which we may need the breeder, so it does not bother me too much that we may be behind some of these countries today in operating plant experience.

I will comment that there is an area where I believe the United States is ahead of the foreign countries, including the French. That is in the fuel systems and the material that goes into the fuel systems in the core. This, certainly, is one of the major successes that we have brought about through the Hanford Engineering Development Lab. Certainly, with efforts with FFTF beyond this, we can further solidify this position. It is my belief that the heart of a breeder reactor is its fuel.

Clinch River will have better breeding capabilities than the French large breeder, mainly because of our innovative core design and what we have already learned from our fuels and material system.

Therefore, it is certainly a concern, but given the date by which we might need the breeder in this country, it does not give me great concern.

Mrs. **Bouquard**. Do you feel we will lose our ability to influence the technology and also encourage nonproliferation if we should abandon CRBR?

Mr. **Yasinsky**. Certainly, if we would abandon Clinch River and abandon our program, we lose the very, very important role of being a leader in dialoging and determining with the other major countries throughout the world how this technology should be utilized and how its fuel cycle should be controlled and safeguarded.

I think we are all very sensitive to those issues. Certainly, maintaining a viable program—a leadership program—in this country is essential to our having a leadership role in that dialog and discussion.

Mrs. BOUQUARD. One other subject that I want to touch on today is one that we referred to yesterday. What is the current break-even cost of uranium to make reprocessing economical?

Mr. KEARNEY. Are you referring, Madam Chairman, to light water reactors? First of all, obviously, for breeders we need reprocessing. That is an absolute necessity.

Mrs. BOUQUARD. I am referring to the breeder, to the need that we will have.

Mr. KEARNEY. Well, you know, technologically, we need reprocessing for the breeder so there is no break-even cost.

Mrs. BOUQUARD. Yes; well, for instance, let's look at it this way: The Los Alamos Scientific Laboratory prepared a report—I am sure you are familiar with it—which DOE disagrees with. It indicates that LMFBR fuel cycle isn't competitive with the current cycle until uranium prices are more than $165 per pound.

I wanted your comment on those numbers.

Mr. KEARNEY. I must have misunderstood you, and I apologize. I thought you were talking about reprocessing.

As far as the break-even cost is concerned, EEI, itself has not made any studies. I think there are others though that indicate that it is lower than that figure.

However, the important point that I would like to make is all of the factors that are involved in making these decisions—what is the cost of uranium, what is the capital cost of a breeder, what is the amount of uranium that you have, what is the growth rate of electricity, what is the price of other competing fuels? There is a certain degree of uncertainty in all of those.

I think the important thing is that eventually we are going to need the breeder, and it is going to take time to develop that to a commercial reality.

Therefore, I do not think we should stop and start on the basis of one number. You gave me a number of $165. I have heard other numbers.

Mrs. BOUQUARD. In other words, you do not feel that the price of uranium should be considered?

Mr. KEARNEY. That is correct. It should not be considered in isolation. Even if it were, I think that there are studies that indicate that breakeven is below that. Maybe one of these gentlemen here would like to comment in more detail on that.

Mr. YASINSKY. Madam Chairman, the kind of analyses that result in estimated break-even costs for uranium require a large number of assumptions, so that as you vary these assumptions, you can come up with significantly different results.

One example I would like to give you is the very extensive analysis that was done as part of the international nuclear fuel cycle analysis which took a look at the situation by large countries, as well as from a worldwide basis. The majority of these assessments that were done in the large nuclear countries throughout the world indicated a break-even cost of about $100 per pound. The capital cost of the breeder is another factor.

The assumptions made in the international fuel cycle evaluation studies ranged for the breeder reactor being from 25 to 75 percent more capital costly than an equivalent light water reactor.

Assumptions as to the amount of uranium available will have tremendous results on the answers you get. These studies indicated a breakeven around $100.

I would like to comment further that studies that have been done both here in this country and elsewhere indicate that the capital cost of the breeder, when mature, can be as low as 25 percent more than the light water reactor.

We also have identified further innovative changes that would depend upon significant research and development that could even lower the capital cost of the breeder to the point where it was about equal to a light water reactor.

I have one final point. I think we can do these analyses for a long time in the future, and as we vary the assumptions, come up with different answers. A key point is that we do not want to time the introduction of the breeder based on when we are using the last ton of economic uranium in a light water reactor. The breeder, as was pointed out earlier, is a machine that permits us to use the valuable uranium resource more efficiently.

Therefore, I believe we should have the breeders operating as soon as possible, as soon as they are economically feasible, but to compliment the light water reactor, and see that the uranium at a lower price is available for even a longer period of time; not only in this country but I believe the United States should be a reliable supplier of low enriched fuel, including the uranium itself, to foreign countries including the Third World developing countries who are interested now in building nuclear powerplants.

By our country and others providing these guaranteed supplies of uranium, we can in effect provide them the disincentive to build their own indigenous sensitive technologies, those being enrichment and reprocessing, and in the long run we benefit the nonproliferation situation throughout the world.

Mrs. **Bouquard**. Thank you very much. I appreciate the answer to that question. It is a different question than the one I originally posed.

What I was really referring to was when does reprocessing become economical in terms of the cost of uranium? I believe that the Industrial Forum reported that the break-even cost of uranium is about $129.

Mr. **Kearney**. What was the figure, Madam Chairman?

Mrs. **Bouquard**. It was $129.

Mr. **Kearney**. I am not completely familiar with that study, but I have seen it. I think that study proposes that the plutonium has value and that it would be recycled. That is a very important element of it.

I think somewhere in that range is probably a correct range.

Mrs. **Bouquard**. I have one final question, Mr. Kearney. In your testimony, you stated that reprocessing should be performed when it is economically justified. Could this lead to a catch-22 situation where the economics is needed to justify the processing demonstration, but the justification can't be done unless the reprocessing is demonstrated?

Mr. **Kearney**. Isn't the correct approach to say—I am glad you asked that question, Madam Chairman. [Laughter.]

That is a very difficult question to answer, and I think it is along the lines of developing any technology. You have to put some money to develop the technology, to make it economic, but you, as you say, have to have the demand for it.

I guess the best way to respond to your question is that at the present moment the economic incentive as far as the utility industry is concerned for reprocessing isn't a high priority in the light water cycle as are other aspects of the backend of the fuel cycle. In other words, what should we do with the spent fuel?

Therefore, if you take that and take into consideration also the fact that there is still uncertainty about the regulatory process or the regulation under which reprocessing can be made commercial, it puts us in a very difficult situation in making any commitment to commercial reprocessing.

Therefore, I am not so sure that satisfactorily answers your question. Let me try to cut through that and clear it up just a little. I would think that we are not going to see commmercial reprocessing for a while in the light water reactor, but we have to do it as far as the breeder is concerned. I think that is the area that we are going to have to concentrate on.

Mrs. **Bouquard**. Thank you.

Mr. **Volkmer**. Madam Chairman, may I ask a question? I was sitting here and talking to staff for a minute, and I was just wondering where we are going to get the reprocessed fuel in sufficient supply for Clinch River.

Mr. **Kearney**. I think I am going to yield to one of these gentlemen.

Mr. **Volkmer**. Somebody tell me where we are going to get it.

Mr. **Kearney**. I think they may be able to answer it a little better than I can.

Mr. **Yasinsky**. This was a point that I briefly alluded to in my opening comments. Where in the past the plutonium that has been provided has, as I understand it, come from the military program, I don't know how much of that will be available for future given the other concerns on the defense side.

My personal feeling is that we may need some reprocessed light water reactor fuel. If we take a look at the light water reactor fuel that is currently in storage, some of it is high burnup and some of it is lower burnup.

The amount of lower burnup light water reactor fuel currently available would be adequate for, I believe, five or six Clinch River type cores. Therefore, this would not be as hot. It would not require all the shielding.

I could envision a possibility of modifying existing reprocessing plants, for example, the PUREX plant up in the State of Washington, or the Savannah River plant, that would permit reprocessing of some of this light water reactor fuel to provide lower burnup plutonium for the breeder program. That is one option.

Now, there are certainly other options that I have heard that could involve collaboration with a foreign country which currently does have reprocessing capability.

Mr. Volkmer. That was what I was saying. Are we going to be buying the reprocessed fuel from France or someplace? Is that where we are going to get our fuel?

Mr. Yasinsky. That is an option available.

Mr. Volkmer. The PUREX plant is going to cost money if you want to get it up to shape, right, reprocessed for Clinch River?

Mr. Yasinsky. Well, the PUREX plant, as I understand it, is being brought back up into operational status for its base mission. To modify the head end——

Mr. Volkmer. All right.

Mr. Yasinsky [continuing]. Would, certainly, involve some cost. I don't know how much, but it would nowhere approximate what would be involved to build a plant from the ground up.

Mr. Volkmer. Would the private utilities be able to come up with the money to do that?

Mr. Yasinsky. I cannot speak for the utility industry.

Mr. Volkmer. I am looking at this, you know, as market this and market that and everything else. Yet, I see all these extra expenses coming in on the taxpayers' side.

Mr. Yasinsky. I have one comment relative to the foreign programs. Reprocessing in general is an area where there are a number of foreign countries that do have a lead, both with regard to thermal reactor fuel and breeder reactor fuel. If in the future there is any further dialog with regard to collaboration, this may be one area that could be very fruitful for the United States.

In this interim period we certainly do not have—and we probably will not have a full-fledged reprocessing plant operating outside of the defense environment.

Mr. Volkmer. I would just like to close in saying that I hope we don't have a plant built by 1988 and have no fuel.

Mr. Yasinsky. As I understand it, and as I indicated before, there are options available. It is my belief that these options are viable, can be pursued, and will provide the fuel——

Mr. Volkmer. And won't cost the taxpayers any money.

Mr. Yasinsky. I cannot comment on that.

Mr. Volkmer. That is my point, you see. You say there are options available. I am sure those options include expense to the taxpayer, but we don't know what the economy is going to be like. We don't know what the budget is going to be like. We really have no guide. We have got options. However, I question how viable they are under the circumstances. That is what I am trying to point out to you.

Mr. Yasinsky. Right now, we do have very valuable fuel in the form of plutonium in the spent light water fuel elements. The question is getting it out and using it, doing it domestically versus in a foreign plant, versus having additional plutonium provided out of the defense side.

Mr. Volkmer. All right.

Mr. Yasinsky. Those are options that I do not have all the information on, so I am sorry, but I really cannot comment further.

Mr. Volkmer. All right. Thank you, Madam Chairman.

Mrs. Bouquard. Mr. Volkmer, from the information I have received, this fuel does come from our military program.

Mr. **Volkmer**. At the present time. That is what it used in the past. However, like you say, there may be some objections to the amount that you may need for the breeder before the Congress. I don't know. We will have to wait and see on that issue.

Mrs. **Bouquard**. We have been assured that they do have sufficient amounts of plutonium.

Mr. **Volkmer**. From Savannah?

Mrs. **Bouquard**. From our military program. Yes.

Mr. **Volkmer**. All right.

Mrs. **Bouquard**. Are there further questions, further comments from the panel?

Mr. Lowery?

Mr. **Lowery**. No.

Mrs. **Bouquard**. If not, I want to thank all of you for being with us. It has been very informative, and your testimony is certainly very well prepared, and we appreciate your sharing your knowledge with us today. Thank you very much, gentlemen.

Our next witness is Mr. William Dircks who is the Executive Director for Operations of the U.S. Nuclear Regulatory Commission. We are looking forward to hearing from Mr. Dircks at this time.

Mr. Dircks, you may proceed with your testimony. We certainly welcome you to the committee today.

STATEMENT OF WILLIAM J. DIRCKS, EXECUTIVE DIRECTOR FOR OPERATIONS, U.S. NUCLEAR REGULATORY COMMISSION, ACCOMPANIED BY PAUL S. CHECK, DIRECTOR, CLINCH RIVER BREEDER REACTOR PROGRAM OFFICE, U.S. NUCLEAR REGULATORY COMMISSION, AND ROBERT B. MINOGUE, DIRECTOR, OFFICE OF NUCLEAR REGULATORY RESEARCH, U.S. NUCLEAR REGULATORY COMMISSION

Mr. **Dircks**. It may be helpful for me to begin with a brief description of the NRC breeder research program and then address specifically the Clinch River project.

NRC has sponsored research in liquid metal fast breeder reactor safety since 1974. Since that time, NRC research on liquid metal fast breeder reactors has focused on the development of methods for the analysis of plant systems behavior under transient conditions, core disruptive accidents, thermal hydraulics, and containment performance.

Experimental programs have developed data on aerosol behavior, high temperature materials behavior, accident energetics, and sodium/concrete behavior. In addition, our past research programs aimed at the resolution of light water reactor safety issues have had some generic applicability to the LMFBR program.

I wish to emphasize that our current budget request contains only funds to support the CRBR licensing review. It does not contain any funds for a broad-base breeder program or the accompanying fuel cycle program.

If commercialization for a broad LMFBR program and supporting fuel cycle programs were to proceed, then there will definitely be an additional need for more and expanded research programs on the part of our agency.

Our current breeder research program amounts to $5 million in fiscal year 1982 and $10.5 million in fiscal year 1983. All of this funding, as I have said, is directed at providing information needed for the CRBR construction permit and operating license reviews.

In developing this program, our licensing staff and our research staff have had numerous discussions with the Department of Energy to assure that our programs are coordinated and that all the information necessary for the licensing effort will be available when needed.

This interaction, I have to stress, is essential. The task of developing the supporting base technology for the LMFBR and specifically for the CRBR is the responsibility of the Department of Energy.

The NRC expects the Department of Energy base technology program will provide the body of research necessary to support the applicant's case, and we do have this fairly firm understanding with DOE on this point.

Now, in addition to the CRBR research program, I should point out that our budget contains $2.8 million in fiscal year 1982 and $1.7 million in fiscal year 1983 for contractual technical assistance in licensing the CRBR.

The Office of Nuclear Reactor Regulation and the Office of Regulatory Research have so far identified research programs expected to cost $5 million in fiscal year 1982 and $5.2 million in fiscal year 1983. They have not yet completed designation of the remaining $5.3 million we have budgeted for fiscal year 1983.

Attached to the end of my testimony is a table showing how these funds will be distributed among the national laboratories.

At this time, our Office of Nuclear Reactor Regulation and our Office of Regulatory Research are continuing to evaluate expected research needs in order to specify the details of additional projects that will be carried out in fiscal year 1983.

Until that evaluation is complete, it is not possible for us to break this funding out by laboratory. While it is too early to be very exact, we expect Sandia and Los Alamos National Laboratories will support approximately 60 percent of the overall NRC program. Brookhaven National Laboratory will provide approximately 20 percent, and Argonne, Oak Ridge, and Idaho National Laboratories will provide the remaining support.

A brief summary of the areas that are being addressed by our research program include: CRBR heat transport capabilities, CRBR accident analysis and delineation, capability of CRBR containment to accommodate core disruptive accidents, and capability of CRBR primary system to accommodate core disruptive accidents.

Specifically, I would like to talk now about the CRBR project—the licensing effort. Turning to the status of the CRBR application, you will recall that at the applicant's request, the NRC resumed its review of the Clinch River breeder reactor plant construction permit application in September 1981.

In order to properly focus NRS's management attention on this important project, we have established a CRBR program office reporting directly to the director of nuclear reactor regulation. The Commission also specified that I should also be held responsible for tracking the project and reporting the project's progress directly to the Commission.

In fiscal year 1982, we have allocated about 25 staff years in the nuclear reactor regulation program to support this licensing effort. Our fiscal year 1983 budget request envisions a similar level of effort.

In addition to these resources, we have resources set aside in our Office of Inspection and Enforcement and in our nuclear materials safety and safeguards programs for the CRBR review.

Public hearings on the CRBR plant have been reopened and a prehearing conference was held in February in Oak Ridge, Tenn.

The presiding Atomic Safety and Licensing Board has ordered the evidentiary hearings to commence in August. In November 1981, the applicants requested an exemption under CFR 50.12 in order to begin site preparation in March 1982 and thereby complete the plant in 1988. As you are no doubt aware by now, the Commission has recently denied that exemption request. Assuming this decision stands, we expect the licensing of the CRBR to proceed as follows.

We would envision a hearing beginning in August 1982. We would anticipate that a request for the LWA be filed and that a decision on the LWA for site preparation activities be made in June 1983. Under this schedule, we could see a decision on the construction permit in June 1984. Then depending on the progress of the construction of the project, we could envision a decision on an operating license in approximately 1990.

In summary, the near-term NRC program on breeder reactors is tightly focused upon the review of the application of the Clinch River project for a construction permit. The next phase will be directed toward safety issues identified in the construction permit review as requiring resolution for the operating license.

This completes my testimony, and I will be happy to answer any questions.

[The prepared statement of Mr. Dircks follows:]

TESTIMONY OF WILLIAM J. DIRCKS
EXECUTIVE DIRECTOR FOR OPERATIONS
U. S. NUCLEAR REGULATORY COMMISSION

HOUSE SUBCOMMITTEE ON ENERGY, RESEARCH AND PRODUCTION
March 10, 1982

NRC Breeder Research

Madame Chairman: I think it may be helpful for me to begin with a brief description of NRC breeder research and then address specifically the Clinch River project.

The Nuclear Regulatory Commission (NRC) has sponsored research in Liquid Metal Fast Breeder Reactor (LMFBR) safety since 1974. Since that time NRC research on Liquid Metal Fast Breeder Reactors has focused on (1) the development of methods for the analysis of plant systems behavior under transient conditions, (2) core disruptive accidents, (3) thermal hydraulics, and (4) containment performance. Experimental programs have developed data on aerosol behavior, high temperature materials behavior, accident energetics and sodium/concrete behavior. In addition, past research programs aimed at the resolution of light water reactor safety issues have had some generic applicability to the LMFBR.

NRC's current breeder research program amounts to $5 million in FY 1982 and $10.5 million in FY 1983. All of this funding is directed at providing information needed for the CRBR construction permit and operating license reviews. In developing this program, our licensing staff and our research staff have had numerous discussions with the Department of Energy to assure that our programs are coordinated and that all the information necessary for licensing will be available.

In addition to this CRBR research program, I should point out that our budget contains $2.8 million in FY 1982 and $1.7 million in FY 1983 for contractual technical assistance in licensing CRBR.

The Office of Nuclear Reactor Regulation and the Office of Regulatory Research have so far identified research programs expected to cost $5.0 million in FY 1982 and $5.2 million in FY 1983. They have not yet completed designation of the remaining $5.3 million we have budgeted for FY 1983. Attached at the end of my testimony is Table 1 showing how these funds will be distributed among the National Laboratories. At this time our Office of Nuclear Reactor Regulation and our Office of Regulatory Research are continuing to evaluate expected research needs in order to specify the details of additional projects which would be carried out in FY 1983. Until that evaluation is complete it is not possible for us to break this funding out by laboratory. While it is too early to be very exact, we expect Sandia and Los Alamos National Laboratories will support approximately 60% of the overall NRC program. Brookhaven National Laboratory will provide approximately 20% and Argonne, Oak Ridge and Idaho National Laboratories will provide the remaining support.

A brief summary of the areas that are being addressed by our research program include:

a. CRBR Heat Transport Capabilities

b. CRBR Accident Analysis and Delineation

c. Capability of CRBR Containment to Accommodate Core Disruptive Accidents

d. Capability of CRBR Primary System to Accommodate Core Disruptive Accidents

The CRBR Project

Turning to the status of the CRBR application, you will recall that at the applicant's request, the NRC resumed its review of the Clinch River Breeder Reactor (CRBR) plant Construction Permit application in September 1981. In order to properly focus NRC's management attention on this important project we have established a CRBR program office reporting directly to the Director of Nuclear Reactor Regulation. In FY 1982 we have allocated 25 staff years in the Nuclear Reactor Regulation program to support this licensing effort. Our FY 1983 budget request includes a similar level of effort. In addition to these resources we have resources set aside in our Inspection and our Nuclear Materials & Safeguards programs for the CRBR review.

Public hearings on the CRBR plant have been reopened and a prehearing conference was held in February in Oak Ridge, Tennessee. The presiding Atomic Safety and Licensing Board has ordered the evidentiary hearings to commence in August. In November 1981, the applicants requested an exemption under 10 CFR 50.12 in order to begin site preparation in March 1982 and thereby complete the plant in 1988. As you are aware, the Commission has recently denied the exemption request. Assuming this decision stands, we expect the licensing of CRBR to proceed as follows:

Hearing begins	August 1982
Grant LWA-1 (for site preparation activities)	June 1983
Issue Construction Permit	June 1984
Issue Operating License	1990

In summary, the near-term NRC program on breeder reactors is tightly focused upon the review of the application of the CRBR for a construction permit. The next phase will be directed toward safety issues identified in the CP review as requiring resolution for the operating license.

This completes my testimony. I would be happy to entertain your questions at this time.

TABLE I
Resources in Support of Clinch River
Breeder Reactor Licensing
(Dollars in Millions)

	FY 82			FY 83		
	Research	Reactor Regulation Assistance	Total	Research	Reactor Regulation Assistance	Total
Sandia National Laboratories	$ 2.2	$ 0	$ 2.2	$ 2.3	$ 0	$ 2.3
Los Alamos National Laboratory	1.2	1.1	2.3	1.0	0.8	1.8
Brookhaven National Laboratory	0.6	0.4	1.0	0.9	0.4	1.3
Argonne National Laboratory	0.8	0	0.8	0.6	0	0.6
Oak Ridge National Laboratory	0.2	0	0.2	0.4	0	0.4
Idaho National Engineering Laboratory	0	1.1	1.1	0	0.5	0.5
Pacific Northwest Laboratory	0	0.2	0.2	0	0	0
Undesignated	0	0	0	5.3	0	5.3
TOTAL	$ 5.0	$ 2.8	$ 7.8	$10.5	$ 1.7	$12.2

Mrs. **Bouquard.** Thank you very much, Mr. Dircks.

The Advisory Committee on Reactor Safeguards, Subcommittee on Nuclear Safety Research, recommended that there be an addition of $1 million for research and development of regulatory position on LMFBR's including design criteria and plans for coordinating future research with the DOE.

Is the NRC adequately preparing for licensing the CRBR? Would you explain?

Mr. **Dircks.** We think that the basic accumulation of research is available for us to go at the decision on the construction permit. We do envision more research being needed to answer additional questions. We think we can handle those issues as we approach the decision on the operating license.

Mrs. **Bouquard.** Do you disagree with their conclusion then?

Mr. **Dircks.** I guess we can always talk about additional funds. I think what we have is a satisfactory program at this time. We do not see any shortage of funds to proceed with the construction permit review.

Mrs. **Bouquard.** What are the key issues that you see that are remaining to be resolved in order to begin CRBR site preparation as soon as we can?

Mr. **Dircks.** I think that issue will revolve mostly around the environmental review. The hearing is due to start. We do not, right now, I believe, have any outstanding issues on the overall environmental program.

I am sure we are engaged with an active dialog with the Department of Energy pursuing additional questions on the fuel program, where the fuel is coming from, the fuel cycle issues that we will need answers to in order to complete our impact statement and to proceed with a hearing.

I do not see that there is any overwhelming obstacle to our completion of that work. I think that the Department realizes the necessity of providing us the information as currently as they can get it to us. We have an understanding that if I see any lags in their supplying of the information to us, I can get directly to Assistant Secretary Brewer and make our requests known directly to him.

Mrs. **Bouquard.** Thank you very much. Mr. Lowery?

Mr. **Lowery.** Thank you, Madam Chairman.

Mr. Dircks, I understand that the NRC breeder office for CRBR has been closed for some time. It just reopened last fall?

Mr. **Dircks.** Yes, sir.

Mr. **Lowery.** Do you all feel that the Commission had sufficient data on which to base a decision regarding Clinch River and the exemption, in view of the fact that it has not been operative for 4 years?

Mr. **Dircks.** The issues that were looked at by the Commission in regard to that exemption were quite narrow. I think they had the information available. Our project office that we established last year is principally engaged in the safety review of the project and pursuing the licensing review.

The project office itself did not participate too heavily in the Commission action on the exemption request.

Mr. **Lowery.** Could you be a little more specific?

Mr. DIRCKS. The exemption was filed directly with the Commission. The staff—and I am talking about the licensing staff—did not play a heavy role in that review.

Mr. LOWERY. Well, what did the Commissioners rely on for information?

Mr. DIRCKS. Well, they relied on the input from the parties that testified, and the input from the Department. They also relied considerably on the Office of Policy Evaluation which is the office assigned directly to the Commission staff to review and evaluate the exemption request and the submissions by the parties.

Mr. LOWERY. If my understanding is correct, several of the Commissioners criticized the total cost presentations saying that they didn't understand the projected cost savings as claimed by DOE.

Are you telling me that possibly there were not sufficient manhours for analysis, and even if there were, the Commissioners didn't seem to necessarily rely upon some of the staff support?

Mr. DIRCKS. Oh, they relied on their supporting office at the Commission level. They also relied on the examination of the documents that were filed with them.

I am not an expert on that particular proceeding since the Commission held that action to itself and did not have the staff as a party to that proceeding.

Mr. LOWERY. How about the projected cost savings in beginning the project earlier than was originally anticipated?

Mr. DIRCKS. Yes. That was again—the review of those cost submissions, as I understand it, was done by the Commission staff and the staff of the offices assigned directly to the Commission.

Mr. LOWERY. I want to go to another area. How do you coordinate your activities with DOE so that we can avoid duplication and any kind of potential conflicts?

Mr. DIRCKS. We have the project office as you have noted. They have been holding frequent meetings with the Department. There has been a good interchange of information between the Department of Energy and the project office. As I mentioned, if there are breakdowns, if there is not enough responsiveness from the Department, I have the understanding with the Assistant Secretary that I am to get in touch with him directly to keep the process moving.

Mr. LOWERY. What do you see as the key issues yet to be resolved to commence CRBR site preparation just as soon as possible?

Mr. DIRCKS. I think the biggest issue now is to take the question before the hearing board. There will have to be a litigation of those issues before the Atomic Safety and Licensing Board to complete the environmental review and settle the environmental issue.

Mr. LOWERY. You have described the process, but what issues do you anticipate as being necessary to resolve the question?

Mr. DIRCKS. I do not see any overwhelming major problems from the staff's standpoint in completing our environmental impact statement or reviewing the impact statement submitted by the Department.

There are no, I think, really overwhelming issues that the staff sees.

Mr. LOWERY. What underwhelming issues are you anticipating?

Mr. DIRCKS. What?

Mr. LOWERY. What underwhelming issues do you anticipate?

Mr. **Dircks**. I suppose there will be need to complete the information on the fuel cycle issues surrounding the project, where the Department intends to get the fuel, how it intends to supply the fuel to the reactor.

The unknowns that come in when you enter a contested proceeding are basically the questions that I think will be brought in by the intervenors.

Mr. **Lowery**. Like the stars in the sky. Thank you very much. Thank you, Madam Chairman.

Mrs. **Bouquard**. Thank you very much.

Mr. Lundine?

Mr. **Lundine**. What are the safety issues which you might have to address with respect to the Clinch River breeder reactor?

Mr. **Dircks**. Let me now turn to Mr. Check who is the head of our project office which is the principal office that is directing the safety review.

Mr. **Check**. Madam Chairman, the summary presentation of Mr. Dircks touches on the principal research programs. I think that is a good guide to the principal safety issues. If we recall, he mentioned the need for studies on the question of heat transport capability. In the event that normal heat removal circuits are interrupted for a reactor, it is essential to demonstrate with confidence that there are alternative paths. This is one area that we are examining.

The applicant, of course, makes a presentation that this matter is well in hand and for the following reasons. I am not going to give you the following reasons, but I point out that we try to reach judgments independently of the analysis that he has done.

Therefore, this topic of heat transport capabilities revolves around a confidence that we have in his analysis. At bottom, there are computer codes that are used. We attempt to do with computer codes that are familiar to us similar kinds of analyses, and thereby independently verify that his predictions are correct.

There are questions, of course, of the primary system itself: that body of material, that pressure boundary, if you will, which contains the reactor core. What is its ability to withstand a variety of upset conditions that we might postulate, however remotely probable, that the plant should have to endure?

Again, because these things are not immediately and easily experimentally verifiable, the applicant and we resort to analyses. These are complex analyses. The analysis performed by the applicant is done with codes that are familiar to him, developed by him.

As is our tradition, we attempt to verify that which applicants present to us and represent to us as adequate through our own analytical tools which is primary system capability, the ability to accommodate core disruptive accidents.

That event labeled "core disruptive accident" could have ramifications also for the containment system which goes beyond and includes the primary system of the reactor.

Here again, if events do not proceed as best estimates would predict, and the impact or the consequences of an accident are not confined to within the primary system, we have provided—that is the design has provided—a capability in a large structurally strong containment building to contain all of the byproducts of this accident.

Therefore, the same story can be told about this. The applicant does an analysis of the complex series of events that might be projected to occur and we try to do a similar kind of analysis, and thereby gain a measure of confidence that we would not have if we relied only upon his presentation.

Mr. LUNDINE. In your testimony, you give us some idea of the amount of money that you are allotting for this research—these research programs. How many NRC personnel are involved in this?

Mr. DIRCKS. In the research programs themselves?

Mr. LUNDINE. Well, let's say in everything that you are doing relating to CRBR.

Mr. DIRCKS. Throughout the whole agency, I think we are talking about 25 in the Office of Nuclear Reactor Regulations, and then for the rest of the agency in terms of staff years it is probably another 5 personnel.

Mr. LUNDINE. Both the amount you are contracting out and intend to contract out and these personnel, would that affect your capacity to deal with light water reactor issues?

Mr. DIRCKS. In the 1982 budget, we did face up to this issue. We feel the use of these people in these numbers of staff years have not detracted substantially from our work on other reactor issues. When we put together the 1982 budget and the 1981 reprograming, we looked at the total licensing effort, and the breeder was considered among that as a part of our effort as an issue. We felt that we could carry out the licensing program for all light water reactors as we are doing, plus carry on the breeder program, and with minor changes we could carry out the rest of the safety programs as well.

I think, specifically, what we did do was look at the total action program, the cleanup program, and the redress program that we have going on in the agency, and concluded that we could essentially carry out that action program doing all the priority one action items and most of the priority two, with only some deferral of the longer term priority three actions. Therefore, yes, we are carrying out the reactor safety program and the reactor licensing program.

Mr. LUNDINE. So essentially you are saying that you have added to your budget to do this, and that you haven't decreased your efforts in other areas because of it.

Mr. DIRCKS. The breeder has made very little dent in our overall program.

Mr. LUNDINE. Are there—to turn to a related subject, not directly on point—are there safety implications in the efforts to improve the efficiency of uranium in light water reactors?

Mr. DIRCKS. Let me——

Mrs. BOUQUARD. Mr. Lundine, could we hurry with that question? I think Mr. Hollenbeck has a question that he would like to ask.

Mr. LUNDINE. Oh, sure.

Mrs. BOUQUARD. Then I would be happy to come back to you.

Mr. LUNDINE. Well, in view of the time constraints, if you could send me a written answer on that, I would appreciate it.

Mrs. BOUQUARD. Thank you very much.

[The information follows:]

Question. What safety problems exist with the use of high burnup fuel?

Answer. The present structure as expressed in the Code of Federal Regulations and our Standard Review Plan is adequate for licensing the use of extended burnup fuel.

The Office of Nuclear Regulatory Research has examined the problem in the light of results from an NRC test series in the Power Burst Facility at the Idaho National Engineering Laboratory. The conclusions are that there are no safety concerns requiring prompt attention by immediate research efforts. Also, RES has developed transient and steady-state fuel behavior codes which are capable of predicting high burnup effects such as fission gas release, cladding creep, and gap conductance. Finally, the RES office shares in ongoing DOE and foreign programs on high burnup gas release experiments and high burnup fuel/cladding interaction experiments (Studsvik). Results of these programs will be incorporated into the codes when available.

In June of 1980, each fuel vendor was asked to prepare and submit a topical report for review. The reports are to cover extended burnup experience, methods, and test data. Four of the five vendor reports are to be submitted to NRC by May 1, 1982 and the fifth report is to be submitted by mid-summer 1982. These reports will provide the basis for NRR generic review and eventual approval will be given of specific fuel designs for specific burnup levels.

Mr. HOLLENBECK. Thank you, Madam Chairman.

Mr. Dircks, I missed the bulk of your testimony, but I noticed in the budget that the research allocation has more than doubled between fiscal year 1982 and fiscal year 1983 from $5 million to $10.5 million, but you have only allocated some $5 million in the research area. I was curious as to what you see as your priorities for the other $5.3 million. It is on table 1, the resources in support of Clinch River breeder reactor licensing.

Mr. DIRCKS. All right. Let me see if I understand that question. You were wondering about——

Mr. HOLLENBECK. Yes. You have got $5.3 million listed under research as undesignated, and I wondered what, if any, priorities you have or will be designating.

Mr. DIRCKS. Oh, where that additional $5.3 would go?

Mr. HOLLENBECK. Yes.

Mr. DIRCKS. Let me ask Mr. Minogue who is the director of our research program.

Mr. MINOGUE. Thank you. Let me explain the situation. The money that you are looking at in the current fiscal year represents reprogramed money. The budget in the current fiscal year was originally zero. What we have done in effect is to reactivate a program to try to deal with some of the residual issues that might bear on Clinch River licensing. Recognize that there was a lot of work done in prior years.

We are still in that process. There are still uncertainties as to the exact scope of some of the issues, the amount of work that will be required, what the costs are. We are in a mode now where we can clearly define half of what we estimate to be the total, but we are still very actively trying to deal with what amounts to a dynamic reprogramming situation.

Mr. HOLLENBECK. I see we have a vote. Could we get further information——

Mrs. BOUQUARD. We do have a vote.

Mr. HOLLENBECK [continuing]. On that for the record?

Mrs. BOUQUARD. Would you like to come back?

Mr. **Hollenbeck**. Could we have that answer in writing for the record?

Mr. **Minogue**. We could write something.

Mr. **Hollenbeck**. Yes. I think that would be easier. Thank you very much.

Mrs. **Bouquard**. Thank you very much. Thank you, gentlemen, for being here.

[The information follows:]

Question. The current research budget of $10.5M for CRBR contains $5.3M in excess of specific request from the licensing program office. Why?

Answer. The budgeted $10.5 million of research funding for CRBR related efforts is generally a restoration of the program level which existed in FY81. This program was reactivated in FY82 in expectation of the resumption of CRBR licensing activity. Funding of immediate projects was delayed until the CRBR Project Office identified its initial research needs. The funding which appears to be excess of this first set of tasks is in anticipation of several factors:

(1) Uncertainty in current projects for experiments and for needed followup work. Refined cost estimates have not been received for all work from selected laboratories.

(2) Uncertainty in the scope and depth of the CRBR Risk Analysis.

(3) As experience is gained through the licensing review process, research areas where additional effort in FY1983 is being anticipated include:

a. CRBR Heat Transport Systems Capabilities

Perform confirmatory calculations to confirm heat transport system capabilities during various modes of operation and conditions including natural circulation.

b. Probabilistic Risk Assessment

Perform a probabilistic risk assessment for CRBR comparable to those performed for LWR in the Interim Reliability Evaluation Program (IREP).

c. CRBR Accident Analysis and Delineation

Perform confirmatory calculations of postulated accidents and evaluate sequences which could lead to accidents more severe than currently recognized.

d. Capability of CRBR Containment to Accommodate Core Disruptive Accidents

Perform confirmatory tests on sodium/concrete interactions and core debris coolability. Perform calculations of containment response to severe accidents and evaluate environment for determination of equipment survivability.

e. Capability of CRBR Primary System to Accommodate Core Disruptive Accidents

Perform confirmatory tests to evaluate applicants position of fuel relocation in core disruptive accidents and to evaluate the threat to the primary system from the energy released in core disruptive accidents.

f. High Temperature Mechanical and Piping Design

Evaluate CRBR high temperature mechanical and piping design. Investigate elevated temperature service non-destructive tests methods.

g. Instrumentation and Control Systems

Evaluate system design and applications.

Mrs. **Bouquard**. Our next hearing on the subcommittee will be on Tuesday, March 16, on our nuclear fission programs. We will hear from DOE witnesses. The committee stands adjourned. Thank you.

[Whereupon, at 3:05 p.m., the subcommittee was recessed, to reconvene on March 16, 1982.]

FISCAL YEAR 1983 DEPARTMENT OF ENERGY BUDGET REVIEW

TUESDAY, MARCH 16, 1982

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met, pursuant to call, at 9 a.m., in room 2325, Rayburn House Office Building, Hon. Marilyn Bouquard presiding.

Mrs. Bouquard. The hearings will come to order. I ask unanimous consent that pursuant to House Rules, television and other recordings of today's hearings will be permitted. Without objection, so ordered.

Good morning ladies and gentlemen. The subcommittee meets today and tomorrow to consider the Department of Energy's research and development programs in converter reactor systems, nuclear waste management, nuclear fuel cycle, and advanced nuclear systems. Today we will receive testimony from the Department of Energy on their proposed budget and tomorrow we will hear from industry representatives and the National Aeronautics and Space Administration relative to their comments on DOE's proposals.

I do want to welcome Dr. Thomas A. Dillon, the Principal Deputy Assistant Secretary for Nuclear Energy, and Dr. Franklin E. Coffman, the Deputy Assistant Secretary for Nuclear Waste Management and Fuel Cycle Programs. And of course, Gordon Chipman we are happy to have back with us this morning.

I recognize that there is a lot of material to cover in the short time available to us, so I will provide a brief description of each of these areas before we hear from our distinguished witnesses.

The work done under the converter reactor systems program category includes research and development on high temperature gas reactors. The committee authorized $25 million in 1980, $40 million in 1981, and $40 million in 1982 for the research and development of an advanced gas cooled reactor which, in addition to furnishing electric power, could supply process heat to various industries such as synthetic fuels production, steel production, and oil shale retorting.

Also included under the converter reactor systems program are the light water reactor systems and the Three Mile Island activities which are developing and improving measures for enhancing safety and reliability of nuclear powerplants. The advanced reactor systems program includes research and development on reduced enrichment research and test reactors.

The activities to be conducted under the civilian waste management program include generic research and development on the waste disposal and repository-specific research and development to be funded from a fee collected from the utilities. It also includes the waste solidification technology project at the West Valley Nuclear Service Center in western New York.

The nuclear fuel cycle category includes work on spent fuel storage technology, as well as other studies on waste and spent fuel storage.

Finally, the Department's advanced nuclear systems program provides the radioisotope thermoelectric generators for NASA's Galileo and international solar polar mission spacecraft. It also includes developmental work for advanced isotope power sources and space reactors which could be used to provide higher power levels required for deep-space and military applications in the 1990's.

Gentlemen, we are happy to hear from you today. Dr. Dillon, we have your written testimony, I believe, which will be made a part of the record so you may proceed as you wish.

STATEMENTS OF DR. THOMAS A. DILLON, PRINCIPAL DEPUTY TO THE ASSISTANT SECRETARY FOR NUCLEAR ENERGY, DEPARTMENT OF ENERGY, FRANKLIN E. COFFMAN, DEPUTY ASSISTANT SECRETARY FOR NUCLEAR WASTE MANAGEMENT AND FUEL CYCLE PROGRAMS, DOE, AND GORDON CHIPMAN, DEPUTY ASSISTANT SECRETARY FOR NUCLEAR REACTOR PROGRAMS, DOE

Dr. DILLON. Thank you very much. It is always a pleasure to appear before the subcommittee. If we do have permission to submit the written statement for the record, I would like to proceed with a very brief summary and some viewgraphs.

Mrs. BOUQUARD. It will be made a part of the record, Dr. Dillon.

Dr. DILLON. Thank you.

The first viewgraph shows the five program elements we will be discussing today as part of the 1983 budget request. All of these reflect some underlying administration considerations in terms of emphasizing long term, high risk, high payoff R. & D., increased reliance on private enterprise for carrying out parts of the programs, a sharpened focus on well defined missions and results; that is, projects as opposed to just level-of-effort activities.

Of course, there is a major influence of budgetary restraint here. The 1983 budget is reduced relative to the 1982 across the board in nuclear energy. Finally these programs cover two of the President's nuclear policy fundamental elements, namely to plan dates to deploy safe means of disposal of commercial high level waste and to streamline regulatory processes for the light water reactor system. I want to point out that the budget element shown for commercial waste management is actually the sum of the appropriation we are requesting plus what we hope will be a user fee. It would be $185 million. So, it is a net number for purposes of comparison with the fiscal year 1982 level.

The next viewgraph shows the budget situation for the converter reactors. The main features there are illustrated. We are requesting no funding for the HTGR during fiscal year 1983. The light water reactor programs show a significant reduction in both increased burn up and safety areas.

Three Mile Island is essentially a continuation of the program at a somewhat reduced level reflecting the contributions of GPU in the overall pace of the cleanup. The RERTR budget shows zero. That now appears in the State Department budget. They have a budgetary request for $4.8 million for RERTR.

The next slide is the Fort St. Vrain reactor in Colorado. Last year Fort St. Vrain ran at full power successfully for about 60 hours. The reactor came down on the basis of a circuit trip but it is regarded by the utility as a very successful demonstration of the capabilities of the HTGR.

We have not requested funding for a variety of factors. Basically what it boils down to is that the principal problem facing the HTGR is the problem of the commercial market. The market for all nuclear powerplants is soft, and it is a very difficult environment for HTGR to penetrate.

That combined with budgetary constraints are what led to the decision not to request continued funding for HTGR.

The next area has to do with the LWR safety. In response to the Light Water Reactor R.D. & D. Act of 1980 we have pulled together a plan. In pulling together that plan, we certainly uncovered the fact that there is a very strong need to pull together a more coordinated national R. & D. program for light water reactor safety.

We have organized at least 10 working groups that started meeting late fall last year. Most of them have been working throughout the winter. They will be making their reports in the spring and summer. They will define a nationally coordinated program.

We have representatives of these working groups from almost every sector involved in the light water reactor business. The reduction in the improved burn up program reflects a strategy of going with one fuel vendor-utility team to bring a single process to completion and then rely on free market forces to encourage introduction of that technology.

We have been encouraged during the past year by the introduction of this technology in programs that are completely unassociated with DOE. There have been five cases of commercial demonstrations that were related to DOE funding, and two or three cases of developmental activities unrelated to DOE funding.

Mrs. **Bouquard**. Would you go into a little bit more detail on that?

Dr. **Dillon**. Sure.

We are very encouraged by the fact that in terms of commercial implementation of extended burn up, Omaha Public Power District is working with combustion in the Fort Calhoun reactor. They are commercially employing burn ups of 40,000 megawatt days per ton. Commonwealth Edison is working with Westinghouse at Zion I and II with high burn ups of 36,900 megawatt days per ton.

Wisconsin Electric is working with Westinghouse at its Point Beach reactors with burn ups ranging from 36,000 to 41,000 megawatt days per ton.

In addition, there are two other utilities working with Exxon and Combustion Engineering with burn ups as high as 44,000. So, we are very pleased that we are starting to see signs of introduction of this. We attribute a lot of it, maybe more than we are entitled to, to some of our earlier demonstration programs. There is a very successful program at Oconee. In addition, developmental extended burn up programs are being carried out at three utilities. They are going for burn ups ranging from 45,000 up to 53,000.

So, we are starting to see private initiative show up in this program. It is very encouraging.

The next element is Three Mile Island. Things are beginning to develop favorably there. We have managed to process all of the water in the reactor sump. There is still a lot of radioactive sludge in the sump of the reactor but I think it is a major milestone that we have been able to process that water. We have clear plans for how to deal with the EPICOR liners and SDS liners.

So, I think the handling of unusual waste associated with the decontamination of TMI is something showing a great deal of promise. We hope that during the rest of fiscal year 1982 and in the beginning part of fiscal year 1983 we will be able to turn this into a solved problem.

In addition, we have begun some demonstrations of decontamination techniques within the reactor vessel that we hope will bring down the overall level of radioactivity in the working areas of the containment to a more convenient working level of about 50 millirem per hour. These techniques will also be used for shipment of the SDS liners when they are loaded and ready to be transferred.

As I mentioned, the RERTR budget is being picked up by ACDA, so there will be continuity in terms of the funding of the program.

Commercial waste management is reflected in the next chart. I have added in the $185 million so the numbers on the right are actually a combination of the appropriation request and the money we hope to obtain from the user fee.

The increase in the terminal isolation programs are just about uniform and they reflect a commitment to actually begin work on the exploratory shafts.

We are trying, on all of the elements of commercial waste management, to instill a very strong spirit and sense of progress, working toward very specific deliverable results and objectives, and accomplishing them on schedule and within budget.

The next slide shows the overall strategy for the waste program. At the bottom you can see we plan to make a decision on the salt site that would be characterized during fiscal year 1983. We will also be identifying the sites in the Hanford basalt flows and the Nevada tuff for the exploratory shafts. We begin construction of those shafts during fiscal year 1983 and in fiscal 1985 we will make a selection of one of those sites for a test and evaluation facility which would be expected to go into operation in the 1989–90 timeframe. Then we will continue the exploratory shafts and site characterization work and in 1988 we will make a license application and, depending on which medium is selected, we expect the commercial repository to go in operation sometime between 1999 and 2002 or 2003.

Next slide. This is not associated with our programs but it epitomizes the spirit of what will be taking place in the terminal isolation program during fiscal year 1983. That is a drill mandrel being used at the WIPP project. That is our objective of fiscal year 1983, actually beginning site exploration with exploratory shaft.

We will continue work in the basalt flows at Hanford at the near surface test facility where we are using electrically heated generators to characterize the medium that will eventually be used for disposal of the waste package.

Next. Turn now to what is happening with regard to low level waste. As you know, the Congress passed legislation in 1980 that set up a concept of regional compacts for low level waste disposal. Progress has been—I think the best way to characterize it—mixed. In the areas and regions where there are operating low level waste burial zones, progress is quite good. The Northwest, Southeast and Rocky Mountain regions all have gotten draft compacts together, introduced into their legislatures. Progress is, I think, very encouraging there. There is every reason to believe that they will successfully have these compacts passed through their own legislatures and ratified by Congress in time for the January 1, 1986, deadline.

Other areas aren't quite so encouraging. In the Midwest and South Central areas draft compacts have been introduced but sites have yet to be identified. This is starting to be somewhat of a concern because we are estimating now that the process for licensing a low level burial ground under the new 10 CRF 61 regulation might be as much as 5 years.

So, identification of a site is something that is quite important. In the Northeast and Mid-Atlantic we don't even have draft compacts yet, so there is still a great deal of work that needs to be done. We are working closely with the States, doing everything we can to encourage progress in this area. As you can imagine this is very important to the overall nuclear option.

This slide is an overview of the West Valley site. In the upper right-hand corner you can see the burial grounds. The ones covered with grass are the State burial grounds. The dirt on the right hand is the NRC licensed burial ground. Toward the center of the picture is where the process building is. To the left there are little circles, I do not know if you can see them there. Can you point those out? These are the actual waste tanks that contain the liquid high level waste that will be solidified.

In any case, on February 25 we were able to take possession of the site and finally, I think, this project is going. We are committed to carrying this program out as expeditiously as possible.

Mrs. BOUQUARD. I am sure Mr. Lundine is happy to hear that.

Mr. LUNDINE. Amen.

Dr. DILLON. Remedial action programs. We are continuing with this. There is no significant reduction in any of the areas. What we want is to have a steady program that will take on these various sites and get the job done. We have had success with Grand Junction. The mill tailings program, I think, is well planned and can accomplish much.

We do have a need to get the standards issued by EPA so we can get on with the job. But we can carry it out.

Mrs. BOUQUARD. Is there a big holdup on that with EPA?

Dr. Dillon. There is somewhat of a holdup. I don't think it is a big holdup. But we have been hopeful for quite some time of having the standards issued this spring.

Now I think it is looking more like the early summer. Still, if we can get the standards—we have been doing a lot of planning, and we are ready to move out quickly if the standards are issued, even in the June time frame.

I think it is important to understand what remedial action is. It is really 99 percent civil works. This slide shows the Salt Lake County fire station where remedial action is underway. It gives a good graphic sense of what is involved.

The next slide shows another scale of remedial action which needs to be done.

In the upper left-hand corner, that large mountain is really a mountain of mill tailings. This is Durango, Colo.

It is a city that depends a great deal for its economy upon the tourist industry. There is a Durango-Silverton narrow gage railroad. You can see the roundhouse for it at the lower left-hand portion of the picture.

Apparently the prevailing winds can carry dust from that pile right over into that area. It's been a bit of a problem for their city in terms of tourism.

I think that it certainly is not a desirable condition. It is not an imminent health hazard, but it certainly is having an adverse psychological effect.

We met with the mayor of Durango recently. He is very committed to doing everything possible to work with us in getting on with stabilizing the situation.

The next chart shows what is going to be a major effort in the area of surplus facilities. We are shutting down the Shippingport reactor and beginning decontamination and decommissioning of that facility.

We will make the decisions in 1982 on the mode of decontamination but this is an example of the kind of facilities we need to address in terms of getting them decommissioned.

NUCLEAR FUEL CYCLE

We have not included anything here with regard to reprocessing. But there are elements that have to do with spent fuel and waste treatment.

The next slide shows what we are doing in the spent fuel area. This is a machine we are testing at AGNS. It will allow us to do rod consolidation by taking apart the fuel elements in a basin and be able to get compactions up to a factor of two.

At some basins, this can lead to very significant expansion for net storage capability. In addition, we will be taking delivery during fiscal year 1983 of a dry cask for storage. These are important remedies that can be used at a reactor site to deal with some of the surplus storage.

We hope these technologies will be available to utilities that have problems in the timeframe when those problems evolve. For some of these utilities, that will be as early as 1986.

Next, with regard the waste treatment technology, this is an example of the kind of activities we are working on in terms of engineering improved systems for handling vitrification of high-level waste. This is a continuous melter.

We have recently submitted a report on monitored retrievable storage concepts. There is an element for conceptual design of an interim storage facility in the fiscal year 1983 budget. It is a $2 million item to look at the conceptual design of what would be involved in that kind of interim storage. It is not a line item in the budget for that kind of facility. It is really intended to be a conceptual design item.

Turning finally to advanced nuclear systems, this is one of the pride and joys of the Department of Energy. It is sort of the Swiss watch of technology. It combines all the precision of flight-qualified technology and nuclear-qualified technology.

These systems that we have developed over the years have all performed in an outstanding fashion in environments and circumstances that are extremely unforgiving.

All of our systems have met or exceeded the systems requirements for their missions and continue to do so. The Voyager mission is just one example of the recent accomplishments of our systems and their performance.

We are working now on the Galileo and solar polar missions. SPAR, the space reactor, is being increased because of the interest of the user, Department of Defense.

Sludge is being picked up by the defense activities. That is more of a transfer of responsibilities.

Next slide. This is an accomplishment that happened last year in the Galileo/solar polar program. We expect during fiscal year 1983, March of next year, to begin delivery of a series of qualification units and flight system units for the Galileo mission.

Next. Here is an artist's concept of what a space reactor would be. We have increased our budget for that. We think there is greatly expanded interest.

There has been continuing interest in this program within NASA, but also recently the Defense Department has really gotten, I think, much more interested in this technology than they have been earlier.

So this is a question of carrying out the development program at a conceptual level in anticipation of a postmission requirement, either at NASA or DOD, in the future.

Well, that is just a very quick touching on all these programs to give a sense of what we have done in 1982 and what we hope to do in 1983. Dr. Coffman, Mr. Chipman and I would be delighted to answer any questions you might have.

Mrs. BOUQUARD. Thank you very much for your excellent presentation. Could we have a copy of your viewgraphs for the record, also?

Dr. DILLON. Certainly.

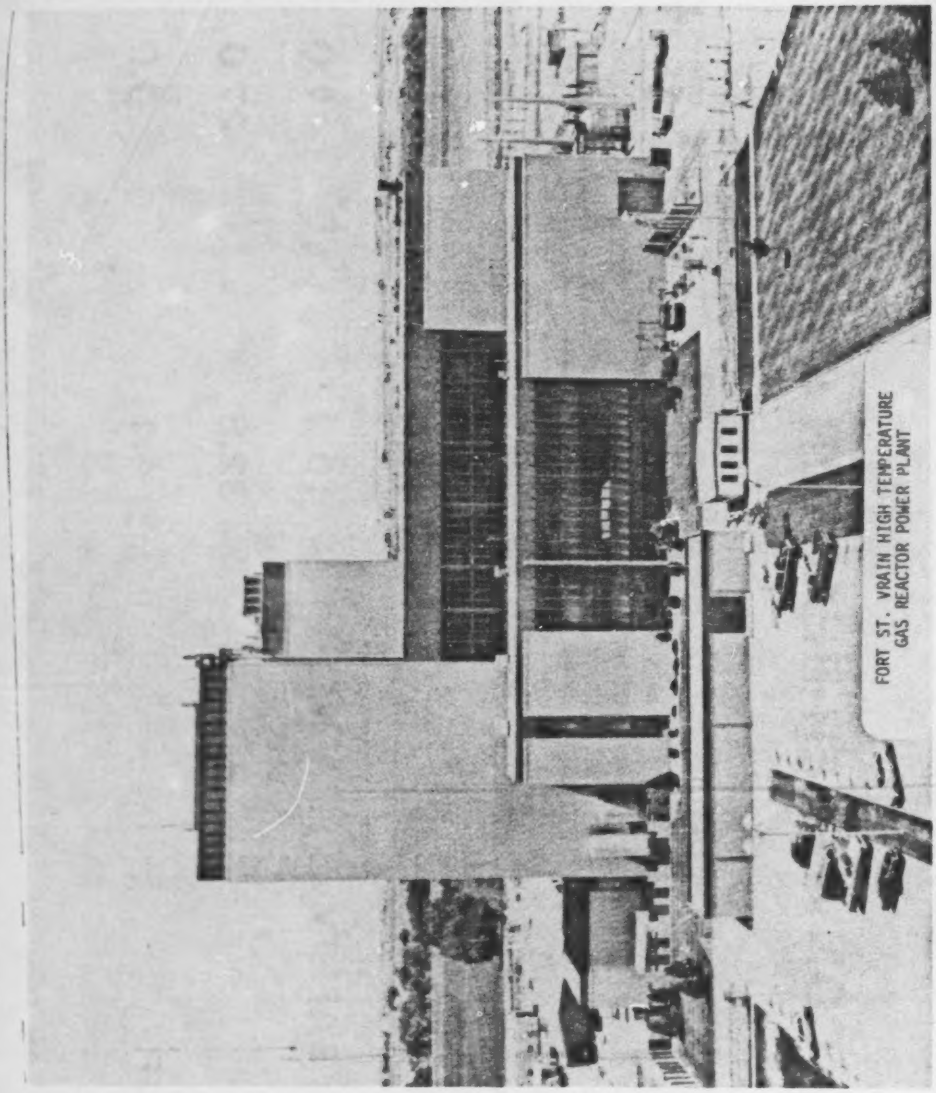
[The viewgraphs of Dr. Dillon's oral presentation, plus his prepared statement follows:]

	FY 1982	FY 1983
CONVERTER REACTOR SYSTEMS	96.3	31.9
COMMERCIAL WASTE MANAGEMENT	210.0	265.5*
REMEDIAL ACTIONS	43.4	50.3
NUCLEAR FUEL CYCLE**	15.1	22.5
ADVANCED NUCLEAR SYSTEMS	37.6	30.6

*INCLUDES & 185M
**EXCLUDING FUEL REPROCESSING

CONVERTER REACTOR SYSTEMS

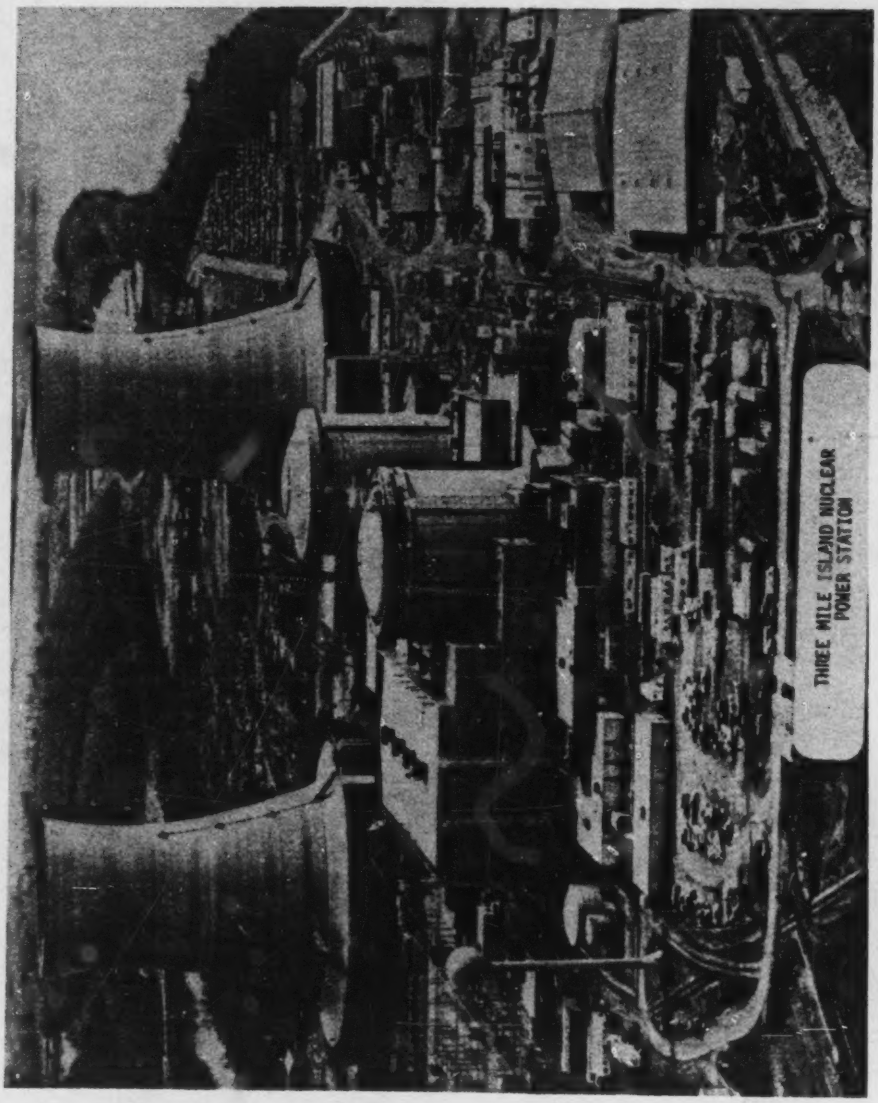
	FY 1982	FY 1983
HTR	35.3	0.0
LWR		
— BURN-UP	11.0	3.0
— SAFETY	10.9	1.0
TMI	32.8	27.0
RERTR	4.1	0.0

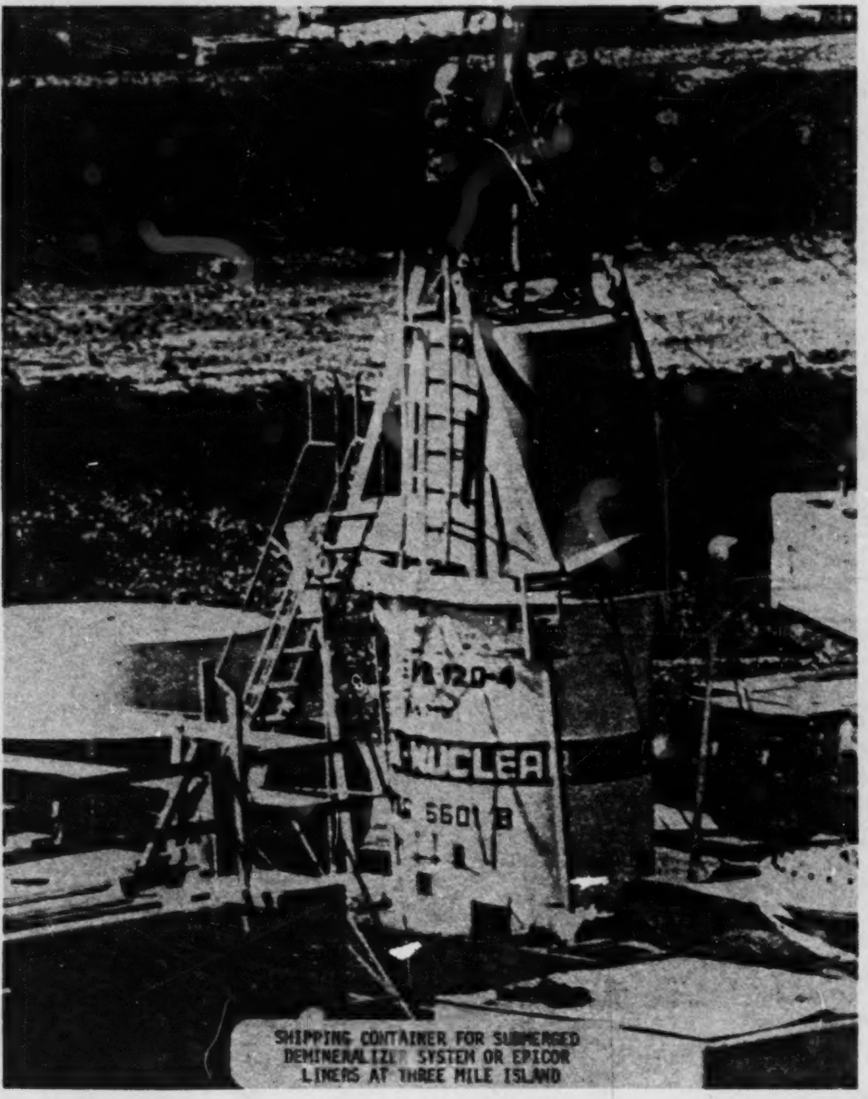


FORT ST. VRAIN HIGH TEMPERATURE GAS REACTOR POWER PLANT

LWR SAFETY WORKING GROUPS

- RISK ASSESSMENT
- DOSE REDUCTION
- INFORMATION AND CONTROL
- FUEL AND CORE
- HYDROGEN
- INSTRUMENTATION
- CONTAINMENT INTEGRITY
- SOURCE TERM
- PERSONNEL AND TRAINING
- SIMULATION


THREE MILE ISLAND NUCLEAR
POWER STATION

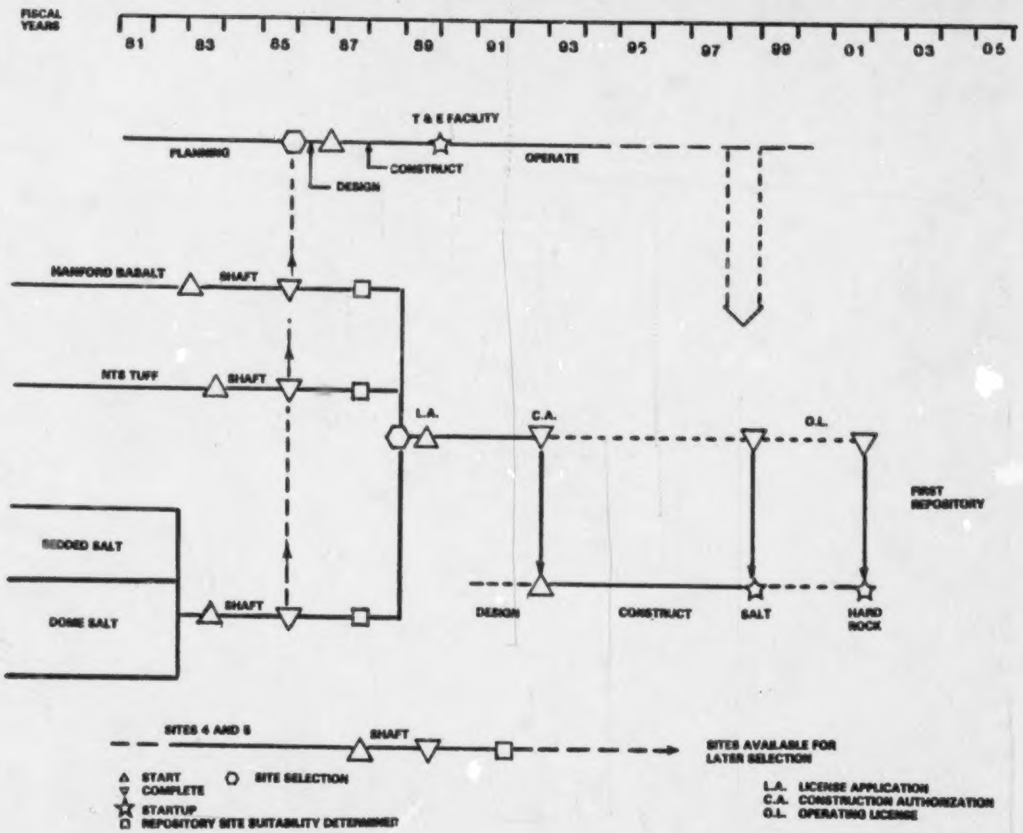

NUCLEA
120-4
5601 B

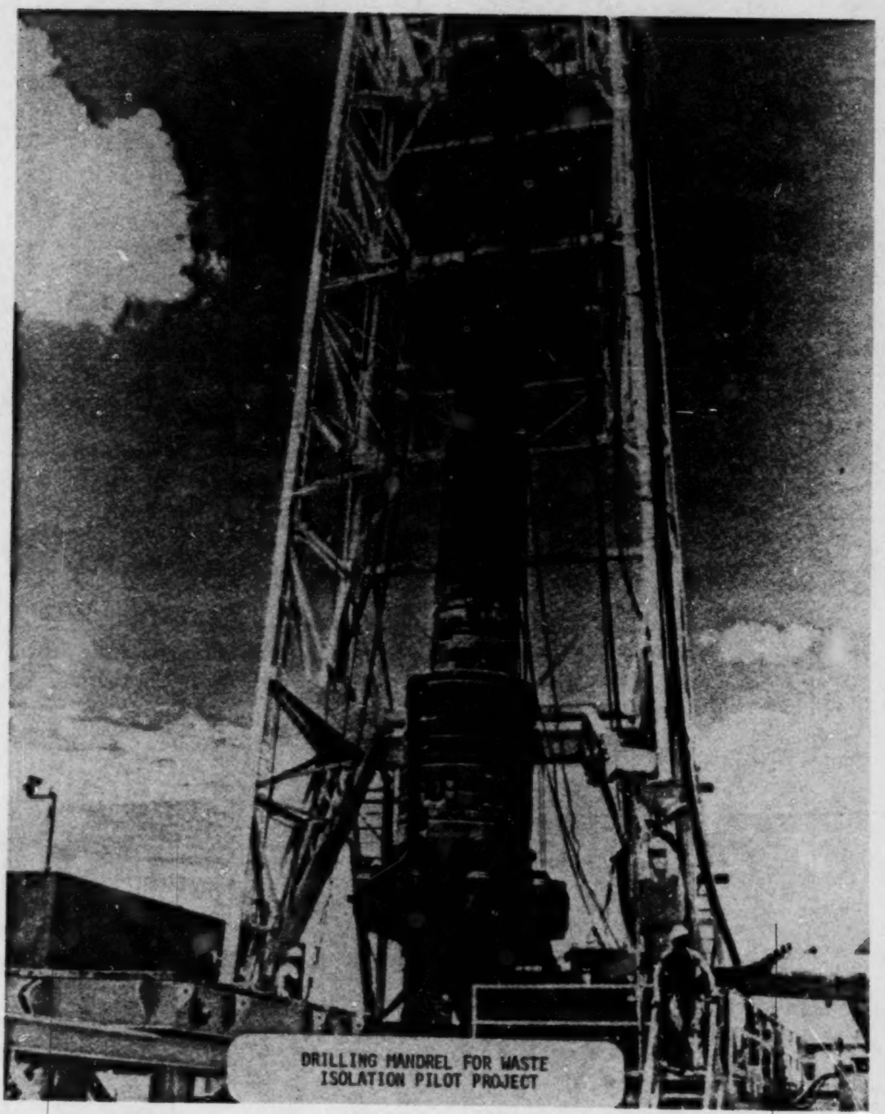
SHIPPING CONTAINER FOR SUBMERGED DEMINERALIZER SYSTEM OR EPICOR LINERS AT THREE MILE ISLAND

COMMERCIAL WASTE MANAGEMENT

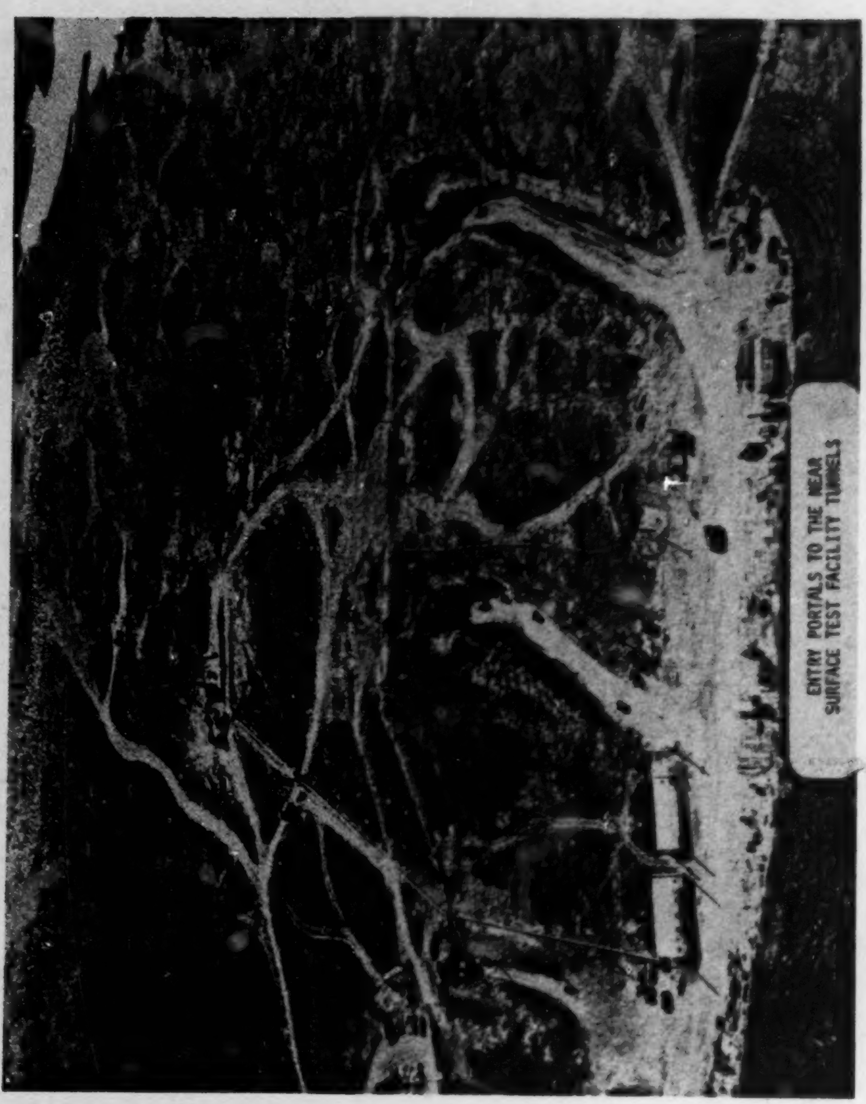
	FY 1982	FY 1983
TERMINAL ISOLATION		
— SALT	107.8	113.4
— BASALT	31.9	51.0
— TUFF	43.0	62.5
— SEABED	3.9	7.5
— TRANSPORTATION	1.5	1.0
WASTE SYSTEMS	9.2	11.4
WEST VALLEY	10.0	15.4

WASTE ISOLATION PROGRAM


FISCAL YEARS
81
83
85
87
89
91
93
95
97
99
01
03
05
T & E FACILITY
PLANNING
DESIGN
CONSTRUCT
OPERATE
HANFORD BASALT
SHAFT
NTS TUFF
SHAFT
BEDDED SALT
DOME SALT
SHAFT
L.A.
C.A.
O.L.
FIRST REPOSITORY
DESIGN
CONSTRUCT
SALT
HARD ROCK
SITES 4 AND 5
SHAFT
SITES AVAILABLE FOR LATER SELECTION
START
COMPLETE
STARTUP
REPOSITORY SITE SUITABILITY DETERMINED
SITE SELECTION
L.A. LICENSE APPLICATION
C.A. CONSTRUCTION AUTHORIZATION
O.L. OPERATING LICENSE

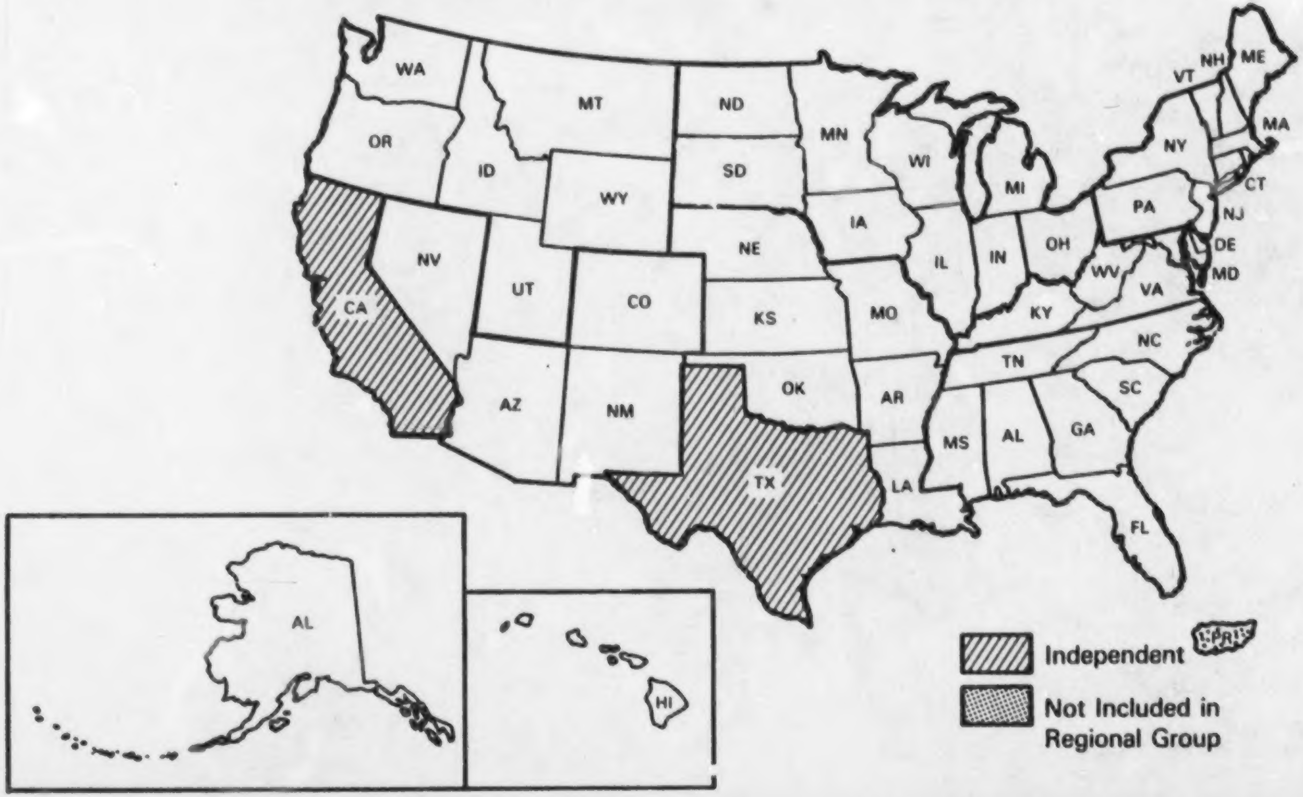


DRILLING MANDREL FOR WASTE ISOLATION PILOT PROJECT



ENTRY PORTALS TO THE NEAR SURFACE TEST FACILITY TUNNELS

Progress in Regional Compact Efforts


WA
OR
CA
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WY
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NM
ND
SD
NE
KS
OK
TX
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IA
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AR
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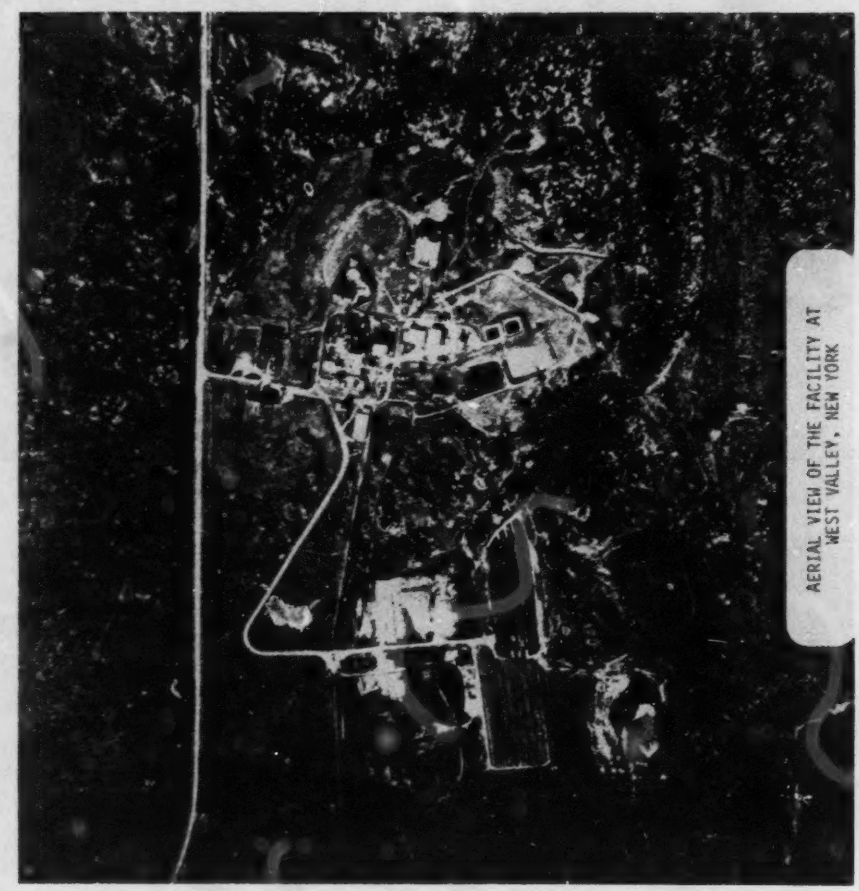
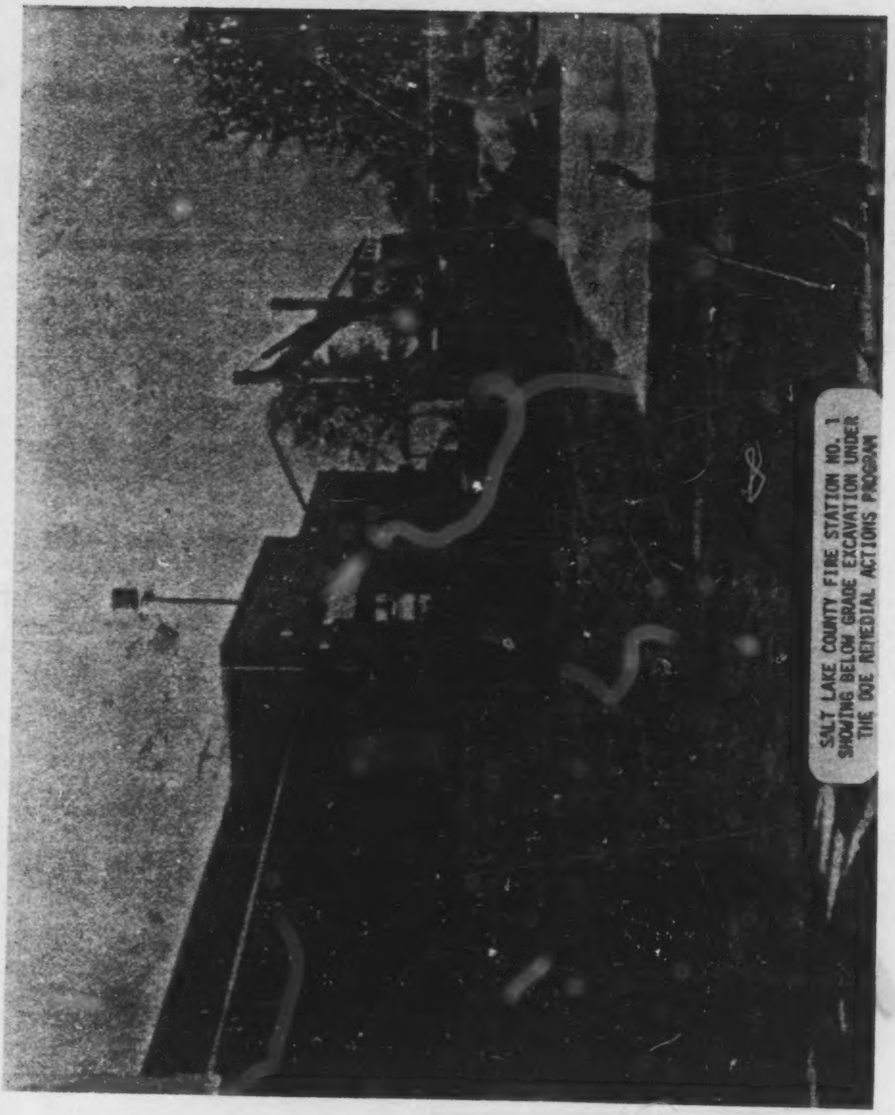
WI
IL
MI
IN
OH
KY
TN
MS
AL
GA
FL
SC
NC
VA
WV
PA
NY
VT
NH
ME
MA
CT
NJ
DE
MD
PR
AL
HI
▨ Independent
▩ Not Included in Regional Group



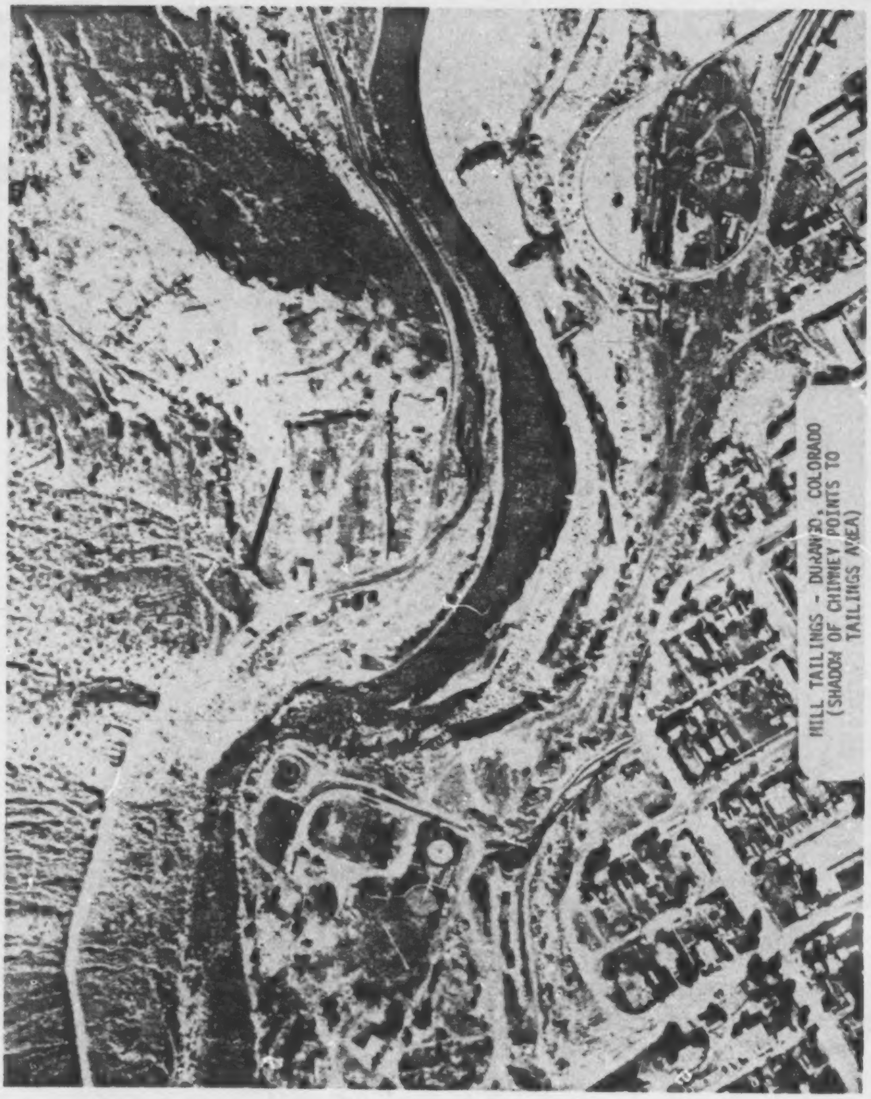
AERIAL VIEW OF THE FACILITY AT WEST VALLEY, NEW YORK

REMEDIAL ACTIONS

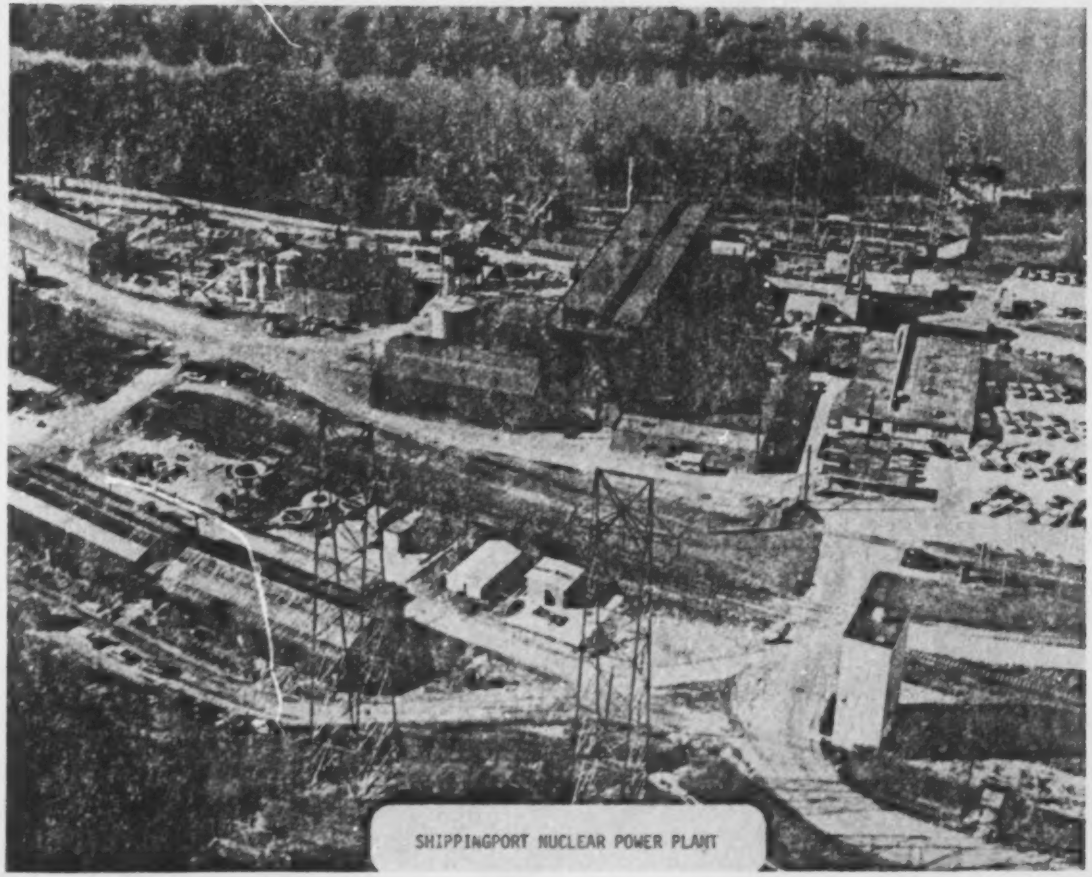
	FY 1982	FY 1983
MED/AEC SITES	11.2	12.0
GRAND JUNCTION	1.7	1.8
MILL TAILINGS	18.2	23.2
SURPLUS FACILITIES	12.0	12.9



SALT LAKE COUNTY FIRE STATION NO. 1 SHOWING BELOW GRADE EXCAVATION UNDER THE DOE REMEDIAL ACTIONS PROGRAM

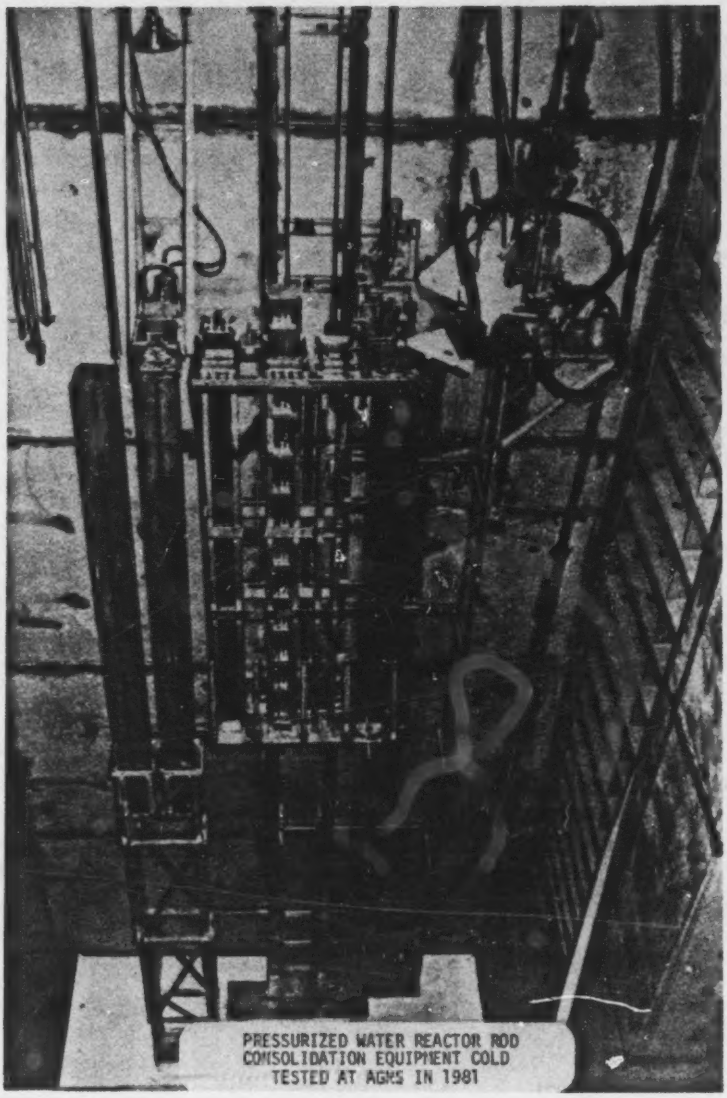


MILL TAILINGS - DURANGO, COLORADO
(SHADOW OF CHIMNEY POINTS TO
TAILINGS AREA)


SHIPPINGPORT NUCLEAR POWER PLANT

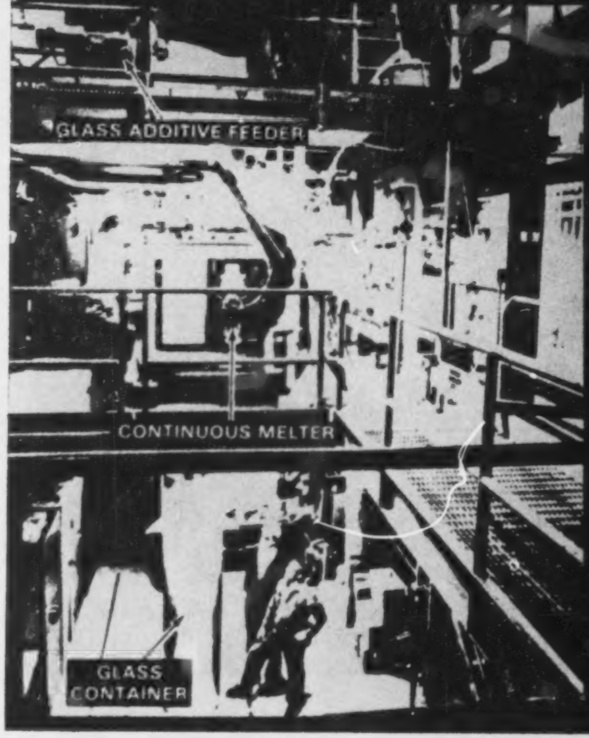
NUCLEAR FUEL CYCLE

	FY 1982	FY 1983
SPENT FUEL	6.8	6.9
WASTE TREATMENT	8.3	15.6



PRESSURIZED WATER REACTOR ROD CONSOLIDATION EQUIPMENT COLD TESTED AT AGNS IN 1981

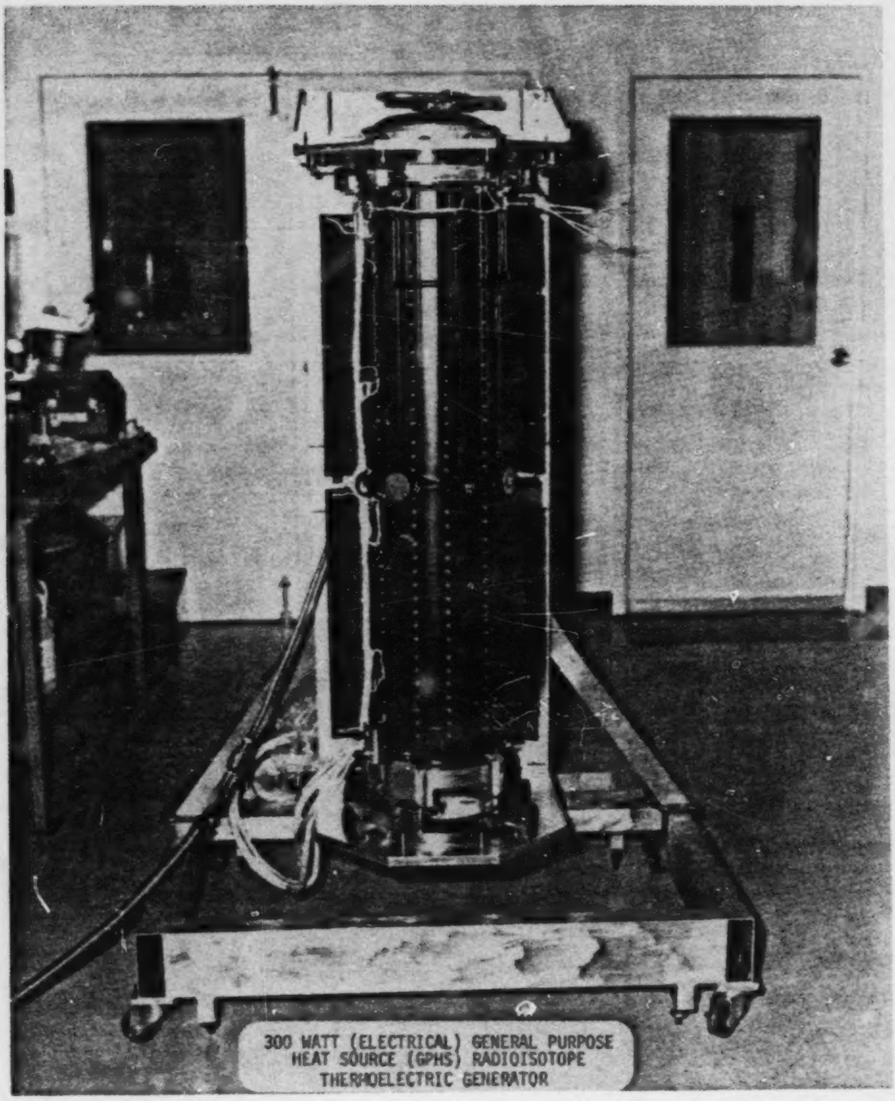
LIQUID FED CERAMIC MELTER


GLASS ADDITIVE FEEDER
CONTINUOUS MELTER
GLASS CONTAINER

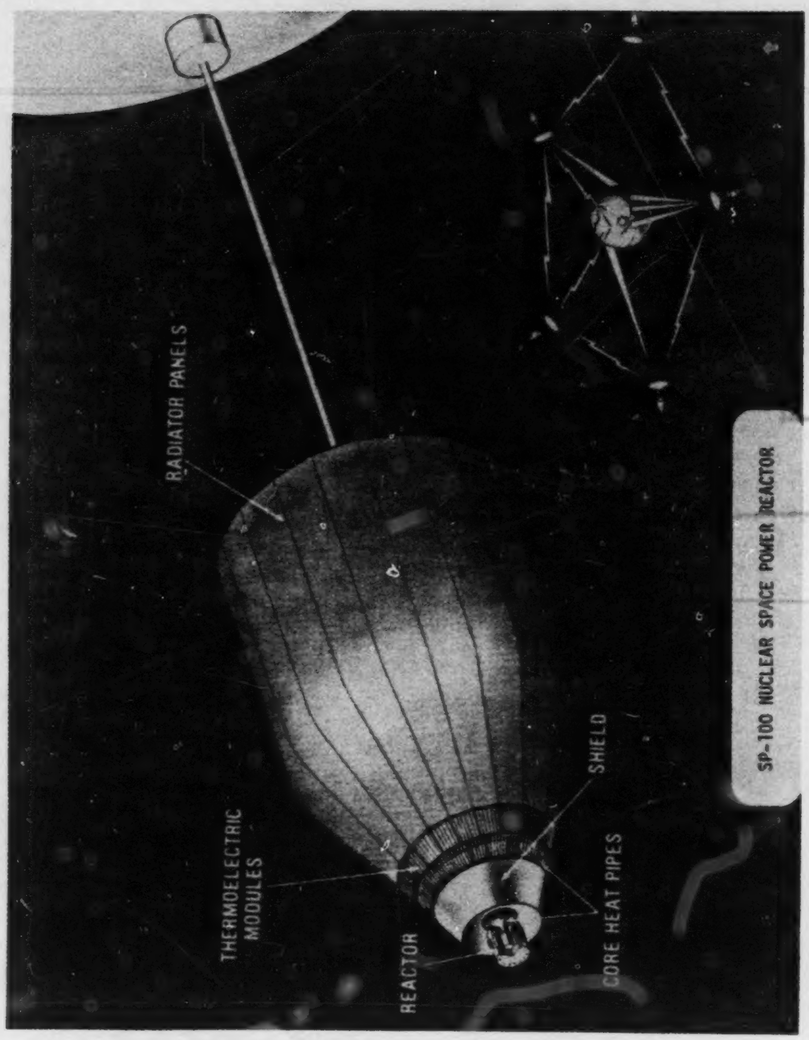
- ACCEPTS LIQUIDS OR SOLIDS
- MELTING SURFACE 1.05 m^2
- GLASS PRODUCTION RATES TO 150 kg/h
- OPERATING TEMPERATURE 1150°C
- POURS GLASS INTO ANY SIZE CAN UP TO 9 ft 10 in. TALL
- NO CALCINER COUPLING AVAILABLE

ADVANCED NUCLEAR SYSTEMS

	FY 1982	FY 1983
GALILEO/SOLAR POLAR	32.2	26.8
SPAR	1.0	2.5
SLUDGE	2.2	0.0



300 WATT (ELECTRICAL) GENERAL PURPOSE HEAT SOURCE (GPHS) RADIOISOTOPE THERMOELECTRIC GENERATOR


RADIATOR PANELS
THERMOELECTRIC MODULES
SHIELD
REACTOR
CORE HEAT PIPES

SP-100 NUCLEAR SPACE POWER REACTOR

STATEMENT OF THOMAS DILLON
PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR NUCLEAR ENERGY
DEPARTMENT OF ENERGY
SUBCOMMITTEE ON ENERGY RESEARCH & PRODUCTION
COMMITTEE ON SCIENCE & TECHNOLOGY
March 16, 1982

Madam Chairman and Members of the Committee, I am pleased to appear before you today to continue discussion of our nuclear fission energy program. At the March 9, 1982, hearing before the Committee, Dr. Brewer submitted an overview of all our programs for the record and discussed the activities of the Breeder Reactor and Nuclear Fuel Cycle Programs. Today I will discuss our programs for Converter Reactor Systems, Nuclear Fuel Cycle other than reprocessing, the Civilian Waste Management programs, and Advanced Nuclear Systems.

CONVERTER REACTOR SYSTEMS

The overall objective of the Converter Reactor Systems program is to enhance the utilization of domestic energy resources. This program will consist of three major elements: Light Water Reactor Systems, Three Mile Island Activities, and Program Direction.

The total funding request for Converter Reactor Systems in FY 1983 is $32.0 million compared to $96.3 million in FY 1982. This request is broken down by program element as follows:

	(B/A in Millions)	
	FY 1982	FY 1983
Light Water Reactor Systems	22.7	4.0
Three Mile Island Activities	32.8	27.0
Advanced Reactor Systems	4.1	0
High Temperature Reactors	35.3	0
Program Direction	1.4	1.0

Light Water Reactor (LWR) Systems

When electric demand dictates, additional nuclear capacity will be sought provided that institutional and financial obstacles are overcome. These obstacles are difficulties in capital formation by utilities, instability of regulatory process, and public perception of nuclear power. Certainly, there is no intrinsic reason why it should take between 10 and 15 years to bring nuclear plants into operation in the United States, when plants in France and Japan can be licensed and constructed in about 5-7 years. One correctable reason this condition exists in the United States is the uncertainty that a utility must face throughout the entire regulatory process, including the construction period and even after plant operation begins. The utilities and their investors simply cannot cope with the resulting uncertainty and significant costs over a 10-15 year time period. In addition, it impacts the public's confidence in perceptions in the ability to provide reliable, economic, and safe nuclear power. The Vice President's Task Force on Regulatory Reform offers an opportunity to correct much of this problem.

The general problem facing the utilities related to formation of capital for projects which offer lower life-cycle energy costs is not unique to the nuclear industry; it also impacts other capital intensive options such as coal. Allowed or realized rates of return are simply not commensurate with utility needs for capital to build new plants. At issue is the financial viability of the electric utilities--an issue which goes to the heart of our economic security. The President's Economic Recovery Plan and his regulatory reform objectives strive to create an investment environment more favorable to utility capital formation.

Supporting the Administration's efforts, the goals of the Agency are:

- Develop the necessary information supporting the Vice President's Task Force on Regulatory Reform.
- Make available Agency facilities to conduct safety research needed to improve overall safety and to reduce costly nonproductive requirements.
- Provide information and impetus to industry efforts to improve design, manufacturing, construction, and testing practices.
- Serve as the Administration's focal point for the support of nuclear power developments; provide factual information to the industry, financial community, and the general public.
- Gather information, perform R&D, and provide technology support to achieve safe and more expeditious Three Mile Island recovery as appropriate to the public interest.

Two major subprograms in Light Water Reactor Systems are LWR Safety and LWR Extended Burnup.

LWR Safety

The objective of the LWR Safety Subprogram is to formulate, coordinate, and conduct R&D to improve reactor safety and support revitalization of the LWR energy option. To achieve this objective, the Department will coordinate the development and implementation of a DOE/NRC/Industry cooperative program that:

A. Defines the institutional and technological issues of priority in achieving these goals; and

B. Identifies the efforts required to resolve these issues.

In response to Presidential and Congressional mandates, including Public Law 96-567 (Nuclear Safety Research, Development, and Demonstration Act of 1980) and to meet the objectives of the Agency program, a comprehensive LWR Safety program, in cooperation with industry, NRC, national laboratories, other Government agencies, and foreign programs, is being conducted. A key effort in this program is the development of a systematic and integrated approach to LWR safety.

As discussed in our response to Congress relative to Public Law 96-567, this program is divided into two phases--a program definition phase and a program implementation phase. In order to define program needs and priorities we are utilizing working groups composed of representatives from DOE, NRC, industry, and national laboratories to assist the Agency in both the program definition and program implementation phases. The Agency has convened 8 of these working groups and their membership and schedule of activities have been provided to Congress in our response to Public Law 96-567.

Major accomplishments in FY 1982 will include:

- Submittal of the three specific studies required by Public Law 96-567 to the Congress by the Secretary on January 29, 1982.
  - A Comprehensive Program Management Plan.
  - A study of the need and feasibility of a National Reactor Engineering Simulator.
  - A study of the sufficiency of U.S. efforts to provide specially trained operators for nuclear plants.
- Completion of development of regulatory reform recommendations.
- Completion of restructuring of the program to meet the program's objectives and thereby be compatible with the needs of NRC and the industry.

The restructured LWR Safety Subprogram supports the goal of improving safety and revitalizing the LWR industry through the following planned activities in Fiscal Year 1983:

1. coordinate and maintain the comprehensive LWR Safety program plan as directed in Public Law 96-567.
2. complete efforts to identify and prioritize safety research requirements.

3. continue efforts to reduce unnecessary technical regulatory burdens.

LWR Extended Burnup

The principal purpose in extending the burnup of LWR fuel is to reduce the generation rate of spent fuel and thereby reduce spent fuel storage and reprocessing requirements. Extended burnup can improve fuel cycle economics and the utilization of uranium resources.

The accomplishments of this subprogram to date have included proof of the capability of LWR fuel to achieve excellent extensions of burnup. Fuel from each of the five U.S. fuel vendors, equivalent to twenty-two fuel assemblies, has been irradiated in seven commercial light water reactors, and selected assemblies have achieved burnups up to 47,000 megawatt-days per ton (MWd/t), a value representing almost two-thirds of the burnup extension being sought. Advanced high burnup fuels designed to achieve the full program goal burnup extensions have been fabricated, and their irradiation has been initiated in two commercial reactors. The Duke Power Company has ordered reload fuel of moderately extended burnup as a direct result of this subprogram, and other utilities are evaluating similar orders. A pure zirconium lined cladding that is resistant to pellet-cladding interaction (PCI) failures, an issue that needs to be resolved prior to broad utility acceptance of burnup extensions, has been developed. Resolution of PCI also contributes significantly to improvement of fuel integrity, plant capacity factors, and of the load following capability of LWR's. A large-scale verification of this remedy, using 144 assemblies incorporating the remedy cladding, has been initiated in a commercial light water reactor.

In prior years, the overall strategy for this subprogram (formerly called uranium utilization) had been to accomplish LWR fuel improvements through multiple cost-shared projects with industry aimed at the development and in-plant verification of the improved technology. This strategy had enhanced and accelerated the level of R&D, had encouraged commercial demonstration and utilization of improved technologies, and had kept the Federal role and cost low. These efforts involved eleven electric utilities, all five nuclear fuel fabricators, two utility-supported organizations sponsoring research and development, and a larger number of European and Japanese organizations.

In FY 1983 the subprogram will be focused to include proving the performance of a single extended burnup fuel design up to established goal burnups, obtaining licensing data to support that and other extended burnup design, and developing other necessary supporting technology. This focusing will result in a single utility/fuel fabricator team becoming the principal contractor for the subprogram. Others in the industry may then follow in extended burnup development and implementation through the natural competitive forces of the marketplace. Technology development and licensing data needs in support of extended burnup are emphasizing PCI remedies and fission gas release data. Of two major contracts for verifying PCI remedies, one will be completed. Several internationally sponsored projects to which we are contributing moderate percentages of their cost are obtaining fission gas release data needed in support of extended burnup fuel design, are determining the PCI-related performance of current and improved fuel designs, and are verifying the capability of extended burnup fuel to accommodate licensing-basis transients.

Three Mile Island (TMI) Activities

The overall goal of the Agency's Three Mile Island activities has been to develop and improve measures for enhancing safety and reliability of nuclear powerplants and to improve the capability to decontaminate nuclear powerplants. To accomplish this goal, we are pursuing a program of carefully examining and evaluating the TMI-2 accident and the response of the nuclear powerplant components and systems to accidents.

In consonance with the Administration's policy of placing responsibility for commercial nuclear power activities in the private sector, the Agency's TMI program is limited to necessary research and development only. Although responsibility for the costs of TMI cleanup is with the owner, the General Public Utilities (GPU) Company, some of the Agency's TMI research activities in FY 1983, such as in-situ inspection of the reactor core, are expected to have indirect benefits to GPU and to offset some of their cleanup costs. Such activities will only be conducted if they offer the opportunity to obtain significant generic research information.

In accordance with a Memorandum of Understanding between the Agency and the Nuclear Regulatory Commission, the Agency will acquire radioactive waste from TMI for research and development, and disposal.

The TMI activity has two major program elements: (1) a TMI Reactor Evaluation and Waste Immobilization Program that was initiated in FY 1982 and (2) a TMI Data Acquisition Program that began in FY 1980.

Waste Immobilization and Reactor Evaluation

The objectives of this subprogram are: (1) to examine the TMI-2 reactor and core components and to conduct research and development associated with the reactor defueling to provide data for evaluation of licensing criteria and requirements, analysis of causes and consequences of accidents, and, improvement of the reliability of the design and operation of LWR's, and (2) to conduct research and development on immobilization of abnormal reactor waste products. The $17 million of the funding request to be applied to this program in FY 1983 will continue the efforts in both of these areas.

The waste management and immobilization activities will initially be focused on an effort to demonstrate the feasibility of vitrifying zeolite ion exchange materials. The program will have demonstrated this feasibility in FY 1982. In addition, the majority of the Submerged Demineralizer System liners and the EPICOR-II liners will be shipped from TMI to Government facilities for R&D purposes.

Beginning in FY 1983, this program will focus on other techniques for the treatment of abnormal wastes produced at TMI, including alternative immobilization concepts, confidence testing, and long term sample observation to provide a more extensive data base. The knowledge gained from this program will contribute substantially to the technology for processing and disposing of unique waste forms resulting from commercial nuclear powerplant abnormal operations and accidents.

The reactor evaluation activities include the examination, removal, and disposition of the reactor core and internals; the development of the special systems, equipment, facilities, and processes needed to accomplish these tasks; and the conduct of supporting onsite and offsite fuel examinations, tests, and evaluations. Through-the-head visual examination of accessible parts of the reactor upper internals and core will be accomplished prior to defueling.

In FY 1983 preparations will be made for reactor head and plenum removal and defueling. The purpose of this activity is to obtain data and information on the condition of the reactor core and other internal components, to conduct the development needed for a thorough examination, and to effectively complete the defueling in as low as practical radiation environment. In addition, it is planned to perform offsite examinations of the fuel and debris to characterize the accident effects.

The knowledge gained from this program will provide data required for evaluating present licensing criteria and requirements; developing future licensing criteria; assessing and developing computer models used to analyze the course and consequences of severe accidents and means to mitigate the effects of such accidents; and evaluating improvements to reactor design, operation, and maintenance.

Data Acquisition Program

The objective of this subprogram is to obtain important R&D data that are of generic value to the safety of light water reactors.

This element of the TMI activities is being implemented in accordance with a Memorandum of Understanding signed by the

Nuclear Regulatory Commission (NRC), Electric Power Research Institute (EPRI), and General Public Utilities (GPU). The efforts of GPU are aimed primarily at plant cleanup and recovery. The Agency has developed a program work scope that will obtain information that would not normally be obtained from the cleanup efforts required. The Agency's program is being conducted to avoid delaying the GPU cleanup schedule.

The Agency and EPRI are sharing responsibility for portions of this R&D program scope. Specifically, the Agency is funding data gathering, research and development, and information transfer in the following major areas: instrumentation and electrical equipment survivability; behavior of radioactive products; data system and specimen archiving; and offsite fuel debris examination. EPRI has similar responsibility for mechanical and structural component reliability, pressure boundary characterization, and decontamination and dose reduction associated with the primary coolant system.

The Agency has established a Technical Integration Office at TMI to manage Government activities, with EG&G Idaho as lead contractor. The technical information being obtained is being provided to the nuclear industry and the NRC through means of reports and seminars.

Some of the recent accomplishments of this subprogram include:

1. Eight electrical instruments were removed from the containment and fifteen electrical components were tested in-situ. Failure modes and effects were assessed and generic design and installation changes were suggested. Several manufacturers of electrical instruments are modifying designs based on TMI program suggestions.

2. Over 400 radioactive samples were analyzed and an initial effort at a mass balance was undertaken.

3. More than 250 detailed photographs were taken in the containment as part of the effort to assess the damage in the reactor building. All vertical surfaces appear to have little or no damage. This assessment leads one to believe decontamination of these surfaces will not be a significant problem. Additional data characterizing the hydrogen burn has been obtained; this provides significant input to an understanding of the hydrogen event. This should impact NRC rulemakings.

4. An EPICOR-II resin liner that was used to clean contaminated water in the TMI-2 auxiliary building was examined at Battelle Columbus Laboratory. The remaining 49 EPICOR-II liners will require gas venting prior to shipment due to combustible mixture of gases being generated in-situ. The TMI program has designed and fabricated a device to accomplish this operation based on data generated by the TMI program at Battelle.

5. A seminar was held with representatives of the United States and foreign nuclear utility industry to describe the status and results of the TMI program.

6. An effort to design and fabricate a high integrity container suitable for disposal of EPICOR-II resin liners was initiated.

The $10 million of the funding request to be applied to this program in FY 1983 will continue the data gathering activities previously described, focusing on additional examination of electrical equipment, radionuclide analysis of samples removed from containment, and developing fuel and core examination techniques.

The electrical equipment information will be used to upgrade qualification standards, regulatory guides, and operating and maintenance standards in order to improve operation of nuclear powerplants during transients. The data on radioactive samples will be valuable in assessing the existing models for fission product release that are used in nuclear powerplant licensing.

ADVANCED NUCLEAR SYSTEMS

The Advanced Nuclear Systems program is responsible for the development and delivery of nuclear power sources for U.S. military and civilian space and terrestrial applications and is responsible for the assessment and maintenance of those nuclear energy sources consistent with the Agency's health and safety requirements. In FY 1983, the activities of the Advanced Nuclear Systems have been narrowed to the major program element dealing with space applications of nuclear power sources. The major undertaking will continue to be the development of the nuclear isotope power generators for use on the NASA Galileo spacecraft planned for launch in 1985, the NASA/European Space Agency (ESA) International Solar Polar spacecraft planned for launch in 1986, and the Space Reactor Technology program (SP-100), initiated in FY 1982 in cooperation with NASA. A previous major program element, Advanced Systems Evaluation, is being phased out to support overall efforts to reduce Federal budgets. Furthermore, beginning in FY 1982 responsibility for the terrestrial applications efforts on the Beneficial Uses of Radioisotopes has been transferred to Defense Waste Management.

The budget request for the Space Applications activity is shown in the following table:

	(B/A in Millions) FY 1982	FY 1983
Flight Systems Development	10.9	14.2
Flight Systems Support	23.0	15.1
Terrestrial Applications	2.5	0
Program Direction	1.2	1.3

Flight Systems Development

This subprogram element includes the design, development, fabrication, and assembly of the isotope space power converter subsystems for the NASA Galileo and NASA/ESA International Solar Polar spacecraft. The isotope qualification converter and several flight converters planned for shipment from General Electric, Valley Forge, Pennsylvania, to the Mound Facility, Miamisburg, Ohio, will be supported by this subprogram element throughout the flight acceptance and qualifiction levels of tests at Mound Facility. The Updated Safety Analysis Reports for both missions are planned to be published. We have initiated discussions with NASA to expand our reimbursable work to include the qualification and spare flight units.

As currently programmed, the Space Reactor Technology Program (SP-100) will be continued in collaboration with NASA. Coordination with NASA and DARPA is now underway with a view to establishing an expanded tri-agency program (DOE, NASA, and DOD) with the DOE as the lead agency responsible for technology and development of the space reactor subsystem. Experimental work to demonstrate technology readiness of the reactor core heat pipe heat transfer system, material characterization and compatibility, irradiation component testing, and reactor control activities will be pursued. Current space reactor component attributes are targeted for a power system at the 100 kW(e) level in the 1800 kg to 2500 kg weight range. Overall system performance characteristics are aimed toward NASA and DOD missions in the 1990's.

Flight Systems Support

This subprogram element supports fuel form production, encapsulation, heat source component manufacturing and assembly, environmental testing of the fueled flight units, and the overall independent safety and safety testing activities. In FY 1983, a significant manufacturing and testing program must be pursued both to meet the tight delivery schedules and the rigorous quality and safety requirements of the program. Iridium blanks fabricated at the Oak Ridge National Laboratory will be provided to the Mound Facility where the iridium is formed into fuel capsule containers. The Savannah River Plant will manufacture 63-watt thermal pellets of plutonium-238 and encapsulate them into the iridium containers provided by the Mound Facility.

Graphitic heat source parts will be procured, fabricated, and assembled for final installation into the thermoelectric converter hardware by Mound Facility staff. Safety analyses and safety testing will be conducted on representative flight isotope hardware components to assess the safety margin of the system by the Los Alamos National Laboratory.

Certain ongoing activities will not be conducted beginning in FY 1983. The independent technical and quality assurance efforts, which support both the flight development and research work, will be phased out. Also, reduction of fuel form production and encapsulation operations at Savannah River Plant is under consideration, in addition to the reduction of assembly and testing operations of flight fueled units at the Mound Facility, and converter fabrication work at General Electric, Valley Forge, Pennsylvania. In addition, the advanced modular isotope generator technology program will not be continued.

We are aware of the House Science and Technology Committee's desire to have the user agencies, such as NASA, reimburse the Agency for hardware units, such as the qualification power unit and the flight spare unit. As you know, NASA currently plans to reimburse the Agency for all flight units delivered in the Galileo and Solar Polar programs. This is a departure from previous practice wherein the Agency provided the first flight unit and flight spare unit to NASA. NASA subsequently reimbursed the Agency for all follow-on units. As I previously indicated, we have initiated discussions with NASA as directed by the Congress.

COMMERCIAL WASTE MANAGEMENT PROGRAM

The objective of the Commercial Waste Management Program is to plan, develop, and implement the technology and provide the facilities for terminal isolation necessary for the long-term management and disposal of high-level and transuranic radioactive wastes produced in the civilian sector primarily from the production of electricity. The budget request for FY 1983 is $80.5 million, (supplemented by the Waste Disposal Fund of $185 million which is not included in this request) as compared to $210 million in FY 1982. Subprogram elements include: Terminal Isolation, Waste Systems Technology, and the West Valley Demonstration Project.

- Terminal Isolation. This activity consists of generic research and development and project-specific efforts leading to the site selection, design, licensing, construction, and operation of high level waste repositories.

  The current overall program strategy is to identify three candidate geologic repository sites at which construction of exploratory shafts to depth will begin in CY 1983, to be completed by CY 1985. The three locations will likely be: in basalt flows on the Hanford Site; in welded volcanic tuff on the Nevada Test Site (NTS); and in a salt formation site to be determined in CY 1983. One of the three sites will be selected for the development of a Test and Evaluation (T&E) Facility. This decision is currently scheduled for CY 1985.

Parallel work on detailed site characterization, necessary before a decision can be made on determining the site or sites to be used for a full-scale licensed repository, will continue at all three sites. A license application for the first repository is scheduled to be submitted to NRC by 1988, with earliest operation estimated to begin in 1998. The repository would be capable of accepting spent fuel in addition to solidified high-level and transuranic waste. These actrivities will be funded primarily by user fees.

The T&E Facility will provide experience and verification of waste emplacement technology. The Facility will be designed for the placement of up to two to three hundred packages of high-level waste which will be completely monitored, and designed for retrieval. Equipment for handling large quantities of waste packages will be evaluated. This experience will assist in the licensing of repositories whether or not the first repository is located at the site of the T&E Facility. Further, it will demonstrate on a practical basis that high-level radioactive wastes can be handled and stored safely.

I would now like to briefly describe our accomplishments and projected activities for FY 1982 and our proposed terminal isolation activities at the requested budget level for FY 1983.

In FY 1982, we will initiate drilling of preliminary boreholes at the salt locations to allow a CY 1983 exploratory shaft site selection for salt. Site characterization work at NTS will allow for an early FY 1983 decision on the site and horizon selection for the tuff exploratory shaft. The exploratory shaft location on the Hanford Site has been identified and confirmatory drilling of boreholes is now proceeding. Technology development efforts include initiating preliminary design of salt, basalt, tuff waste packages, and accelerated barrier materials testing. Conceptual design studies of the T&E Facility will also be initiated in FY 1982.

At the $50.4 million requested funding level in FY 1983 for generic R&D, the terminal isolation program will continue the development of technologies, such as repository sealing, transportation, and performance assessment modeling generic to the geologic media being investigated. Such activities are necessary to support repository design, licensing, construction, operation, and decommissioning. Cooperative activities with other countries will be maintained to foster developments and exchange technology on waste disposal. Related testing continues with Sweden, the Federal Republic of Germany, and Canada on a bilateral basis. Also included is the continued evaluation of the technical and environmental feasibility of subseabed disposal.

We are also requesting $185.0 million in borrowing authority to fund the project-specific activities in FY 1983 until utility fees are available. This funding will allow the construction of exploratory shafts in basalt at the Hanford Site and in tuff at NTS to be initiated in CY 1983, and for land acquisition, design, and long-lead procurements leading to a late CY 1983 construction start of the exploratory shaft in salt at a site identified in CY 1983. The funding would also provide for a very limited continuation of a nationwide screening for additional sites necessary for a system of regionally-based repositories. Preliminary design of waste packages in salt, basalt, and tuff will be completed, and scale testing of these package systems will be initiated. Design studies of the T&E Facility will continue in FY 1983. Other site-specific technology development, such as repository designs for tuff, host rock thermal-mechanical modeling, and hard rock mining equipment development, will be conducted also in FY 1983.

o The Waste Systems Technology Program, with a FY 1983 funding request of $11.4 million, encompasses the following tasks:

Federal/State interactions

This task would provide funds in FY 1983 to allow potentially affected States to participate in the planning and implementation of the site qualification and selection program for mined geologic repositories. This participation is essential in facilitating an understanding at the State level of the issues associated with repository siting and in encouraging confidence that our program adequately addresses the issues.

Supporting studies and evaluations

This task supports the nuclear waste and fuel cycle program in the areas of collection and dissemination of information on international programs; the review of technical programs by the National Academy of Sciences; and the independent assessment of technical and institutional issues.

Low level waste technology

The objectives of this activity are to facilitate the establishment of a reliable system for treatment and disposal of commercial low-level waste (LLW), to facilitate the formation of regional compacts, to transfer improved technology to the private sector, and to foster cooperative technology development demonstrations with the States and industry. Assistance in the timely development of regional LLW disposal sites (required by 1986 per P.L. 96-573) will include comprehensive planning and other support, the assessment of waste generation, waste treatment analyses, site screening and selection methodologies, characterization studies and the demonstration of improved technologies. The technical program will focus in FY 1983 on waste form and volume reduction processes, radionuclide migration, and disposal site stabilization.

- West Valley Demonstration Project. The objective of the West Valley Demonstration Project is to carry out a high-level radioactive waste solidification demonstration project at the Western New York Nuclear Service Center near West Valley, New York, under the provisions of Public Law 96-368, the "West Valley Demonstration Project Act." The project will demonstrate the technology for solidification and preparation for permanent disposal of approximately 600,000 gallons of high level wastes from nuclear fuel reprocessing. It will also provide experience in the decontamination and decommissioning of nuclear fuel cycle facilities and operational experience on the removal and handling of stored waste, and will demonstrate technologies for the decontamination and decommissioning of high-level waste storage tanks.

The removal of high level waste from the storage tanks at West Valley is made difficult by restricted access to the inside of the tanks. Cleanup is further impeded by the variable composition of the waste and a gridwork structure in the bottom of the tank that interrupts clear access of rinsing and pumping devices. One of the first activities will be to develop the tooling and sampling devices for working through the existing access openings and to characterize the waste and design a removal program. We expect that special techniques of manipulation and special tools for sluicing material from the bottom of the tank will be a part of the development required for the project.

The FY 1983 funding request for the project is $15.4 million. Activity will emphasize the establishment of the technical, cost, and schedule baselines for carrying out the project, and the operation, maintenance, and upgrading of the facilities at the West Valley Center. A high priority is being assigned to verification of waste solidification equipment and performance of the solidified waste product, design of the waste removal and processing systems, and decontamination of the facilities for reuse and subsequent final decommissioning.

On November 3, 1980, the Department of Energy and the State of New York signed a cooperative agreement establishing the framework for the implementation of the Project. In July 1981, the Department issued a draft environmental impact statement. Public hearings on the draft EIS and project were held in West Valley on September 26, 1981. The final statement and record of decision are scheduled to be issued this summer. On September 18, 1981, the Department and the State amended the cooperative agreement to resolve some ambiguities contained in the initial agreement. The resolution of these issues permits us to move forward in a cost-effective manner.

On September 23, 1981, the Department and the Nuclear Regulatory Commission (NRC) completed a Memorandum of Understanding as required by the Act. This agreement established arrangements for NRC review and consultation on Project activities, especially as they relate to plans for waste removal, solidification and preparation for disposal, as well as ultimate decontamination and decommissioning. NRC will also be consulted on waste forms, containers, safety analysis and other related reports, and will have access to the site to monitor project activities for the purpose of further assuring the public health and safety. On September 30, 1981, the NRC issued a license amendment to permit licensees to transfer possession of the West Valley facility to the Department. This transfer took place on February 25, 1982.

THE REMEDIAL ACTION PROGRAM

The Remedial Action Program includes four subprograms for the elimination of residual radioactivity resulting from past nuclear operations at certain government-owned sites or at designated non-government sites. The Budget Request for the program in FY 1983 is $50.3 million as compared to $43.4 million in FY 1982.

Formerly Utilized Sites Remedial Action Program (FUSRAP)

The FUSRAP Program covers radioactively contaminated sites that were formerly owned, controlled, or used by the Manhattan Engineer District and the Atomic Energy Commission. Sites included for remedial action under this program have been determined to be insufficiently decontaminated to meet current guidelines for unrestricted occupancy or use. At present, 21 sites have been identified as needing remedial action and another 14 sites as probably needing remedial action. DOE has authority for remedial action at 13 of these sites.

In FY 1982, the cleanup of 27 contaminated properties in the vicinity of the former Middlesex Sampling Plant site at Middlesex, New Jersey was completed and the waste was stored on the Agency-owned site. The final phase of this project is to clean up the site and dispose of all the wastes. Several disposal options are being studied including use of other Federal sites, establishing a new State-owned site, possibly in conjunction with a State or regional low level waste site, or disposal under EPA permit at an Atlantic ocean site. A decision on the disposal option is planned for FY 1983. During FY 1982, cleanup of a privately owned parcel of land adjacent to the Niagara Falls Storage Site (NFSS) at Lewiston, New York was completed and the waste was stored on the DOE-owned site. Planning and engineering for cleanup of several miles of contaminated ditches leading from the NFSS is underway and ditch cleanup will be started in FY 1982 and completed in FY 1983. A contaminated landfill at Norton, Massachusetts was fenced, preparatory to other remedial action that is being planned for FY 1983. Engineering and environmental studies will be completed in FY 1982 for the Bayo Canyon and Acid Pueblo sites at Los Alamos, New Mexico. Remedial action on these sites is to be completed in FY 1983. We have been trying to proceed with a research and development project to stabilize wastes at the St. Louis Airport Site in Missouri, but have been unable to reconcile the issue of long-term responsibility for the site with the city. Cleanup of an off-site area that is the Agency's responsibility will be initiated as soon as the issue of a disposal site is resolved. Preliminary engineering and environmental studies for remedial actions at the Middlesex, New Jersey municipal landfill and the Linde Air Products site at Tonawanda, New York will be completed in FY 1982. Preparations for disposal of the Middlesex wastes will be completed in FY 1983.

Grand Junction Program

Under Public Law 92-314, Congress provided financial assistance to the State of Colorado to limit radiation exposure resulting from the use of uranium mill tailings for construction purposes at Grand Junction.

This Federal/State cooperative effort is conducted under contract to the Colorado Department of Health. The remedial action provides for removal of uranium mill tailings from the premises of about 740 structures where external gamma radiation or indoor radon daughter exposures exceed the Surgeon General's 1979 guidelines. Federal funds cover 75 percent of the program costs, with the State providing the balance.

The program had completed cleanup of approximately 430 of the sites by the end of FY 1981. In FY 1982 remedial actions will be completed for about 40 properties. In FY 1983 about 80 properties will be completed. The cleanup of remaining sites under the program is tentatively scheduled to be completed by 1985 and finally certified by 1987, but the pace of the program is currently dependent on the State of Colorado's providing its share of the funding.

Uranium Mill Tailings Remedial Action Program (UMTRAP)

In November 1978, Congress enacted Public Law 95-604, the Uranium Mill Tailings Radiation Control Act of 1978, which provides for the cleanup and stabilization of uranium mill tailings at 24 non-Federally owned inactive uranium processing sites, which were used for the production of uranium for sale to the Federal Government, and at any nearby properties contaminated with material derived from the sites.

The program will be conducted under cooperative agreements between the Federal Government and the affected States or Indian tribes. Remedial action costs will be shared on a 90/10 basis with the affected States. The Federal Government will pay all of the costs in the case of the Indian tribes.

The current project schedule for work on each of the 24 processing sites is based on the promulgation of final Environmental Protection Agency (EPA) standards for this program, currently anticipated in March 1982. The schedule calls for completion of the program within 7 years following the promulgation of the EPA standards, as authorized by P.L. 95-604.

Nine sites have been given a high priority on the basis of their potential for radiological hazards to the public. They are: Canonsburg, Pennsylvania; Salt Lake City, Utah; Durango, Colorado; the Shiprock, New Mexico site at the Navajo Indian Reservation, two sites at Rifle, Colorado; Gunnison, Colorado; Grand Junction, Colorado; and Riverton, Wyoming. Remedial action on the first processing site is to begin in the first quarter of FY 1984.

Cooperative agreements have been executed with Pennsylvania, Utah, and Colorado. The agreement with Colorado embraces all nine of the sites within that State. A proposed cooperative agreement with which to open negotiations with the Navajo tribe has been drafted and is under review within the Agency.

In response to DOE's presentation of a model draft cooperative agreement to the State of Wyoming, Governor Herschler has expressed deep concerns relative to parts of the proposed agreement. We are arranging to discuss Wyoming's problems with the draft agreement with representatives of the State's Office of the Attorney General.

Cleanup of a seriously contaminated vicinity property, Salt Lake City Fire Station #1, was completed in December 1981 using the interim EPA standards issued for this purpose in April 1980. Plans are in place for starting work on a second group of vicinity properties in Salt Lake City, and on an initial group of properties in Canonsburg, Pennsylvania, in the spring of 1982, pending the issuance of standards by the EPA.

Accomplishments planned for the budget request of $23.2 million in FY 1983 include completion of NEPA documentation (EIS's or EA's) for 11 sites, completion of remedial action plans and some detailed engineering for the first four high priority sites, the continuation of remedial action at vicinity properties at

Canonsburg and Salt Lake City, and start of vicinity property work at Durango and Rifle, Colorado.

Surplus Facilities Management Program (SFMP)

The Agency owns approximately 500 surplus facilities that are radioactively contaminated. About 100 of these are from activities related to development of commercial nuclear energy and are the responsibility of the Assistant Secretary for Nuclear Energy. The other 400 facilities are from defense activities and are the responsibility of the Assistant Secretary for Defense Programs. The facilities include reactors, fuel processing plants, laboratory buildings, tanks, and disposal facilities at about 17 sites throughout the United States and Puerto Rico. The objective is to decontaminate these facilities in order to eliminate the potential for significant personnel exposure or spread of contamination and to permit other productive uses where possible.

In FY 1982, Remedial Actions will continue at the Mound facility in Miamisburg, Ohio. The Mound cleanup, a major project jointly supported by the Offices of Nuclear Energy and Defense Programs, extends through 1988. Decontamination and decommissioning (D&D) of the Sodium Reactor Experiment power demonstration reactors at Santa Susana, California, will be completed in FY 1982. Engineering and planning for D&D of four other facilities at this Agency-leased site will continue in FY 1983. Preliminary engineering and planning for the D&D of the Shippingport Atomic Power Station will be completed in FY 1982. A draft Environmental Impact Statement has been issued for comment and the final statement is to be issued by this spring. The operation of the Shippingport reactor is to be terminated at the end of FY 1982 and the turnover of the facility for D&D work is to occur about July 1984. Other D&D work to be accomplished in FY 1982 includes the Agency-funded plutonium fabrication facilities at the Westinghouse Advanced Reactor Development, and similar facilities at Argonne National Laboratory and the General Electric Advanced Fuel Laboratory in California. The D&D of the reactor facility at the Center for Energy and Environmental Research at Mayaquez, Puerto Rico, and two nuclear rocket test stands at the Nevada Test Site will be completed. Stabilization of the R-10 uranium residues at the Niagara Falls Storage Site will be initiated.

Mrs. **Bouquard**. Let's go to the waste program now, a good place to continue.

I was interested in the criteria you used to separate the program into generic R. & D. and R. & D. to be financed through the fund.

Would you go into that in more detail?

Dr. **Dillon**. I'll ask Dr. Coffman to do that. The criteria in general, of course, are based on the thought that the fund should be used for site-specific activity with regard to the repository.

The more generic work associated with the waste system in general would continue to be funded by appropriations. But Dr. Coffman can elaborate on that subject.

Mr. **Coffman**. I think that is a concise encapsulation of the intent. The work tasks that have to be completed in order to proceed directly to a repository which would house the commercial high-level wastes are charged to the fund. The basic or generic technology, the R. & D. which is not on a direct critical path to the repositories, but which supports the technology base from which we make our basic programmatic decisions falls into technology to be supported through appropriations.

Mrs. **Bouquard**. Would you consider the activities that are to be conducted under the fund as research, development, and technology demonstration?

Mr. **Coffman**. I would; yes.

Mrs. **Bouquard**. Turning to West Valley, are we timing this program so that the solidified waste can be shipped to the test and evaluation facility without having to construct storage facilities at the West Valley site?

Dr. **Dillon**. It is a very important element. We are trying to carry out that program as quickly as possible simply to keep costs at a minimum.

But also so it could be phased in very well with the T. & E. facility which we hope to have in operation in the 1989-90 timeframe; so there should be a very good match between them.

Mrs. **Bouquard**. Turning to Shippingport, do you have any idea of the total costs for decontaminating and decommissioning Shippingport?

Dr. **Dillon**. The cost is very sensitive to the mode of decommissioning we choose.

Mrs. **Bouquard**. There is a little bit of difference in funding levels.

Dr. **Dillon**. Yes. If we took as a mode of decontamination and decommissioning just reducing it back to unrestricted use, a green field concept, it would be very expensive. It could be $100 million. We will be doing studies in terms of the pros and cons of the mode for D. & D. at Shippingport.

We plan to make a decision on that in 1984. That is when we will be able to, I think, give a more accurate estimate of what the cost would be for D. & D.

Mrs. **Bouquard**. You really don't have an idea of the direction, you really don't have a real good ballpark figure, then?

Dr. **Dillon**. Well, we have ballpark figures for a variety of different options. The most expensive one would be where you essentially knock down everything and take it away to a burial ground.

As you can imagine, transportation and disposal charges would be very expensive. It can balloon up to something like $100 million. We understandably would very much prefer a much less costly approach.

We have looked at options. We know less costly approaches are possible, but we don't plan to make a final decision on the D. & D. until the end of this year. One of the things we have to work with is the owner. Duquesne Power & Light is using that site for its Beaver Valley Station.

So I am sure they would like to have beneficial use. There has to be some reasonable compromise.

They, I am sure, would love us to do the most comprehensive decontamination job possible.

Mrs. **Bouquard**. Is there any fee charged in the Shippingport power rates to recover any of this cost?

Dr. **Dillon**. No.

Mrs. **Bouquard**. I would like to turn now to the fuel cycle programs. What utilities are involved in the dry storage demo programs and in the other spent fuel R. & D. programs?

Dr. **Dillon**. Dr. Coffman.

Mr. **Coffman**. We have a couple of programs that we are involved with. We have a collaborative program with the Tennessee Valley Authority where we will take some BWR fuel elements and work a program wherein we make a license application to demonstrate dry cask storage techniques.

The Department's contribution is on the order of $800,000, wherein we buy a cask from TVA. Once the TVA cask is licensed by NRC, it or those of similiar design could be used by utilities in the future.

There is a German firm who is also providing a cask at no cost to the Government or TVA. TVA is bearing the costs of loading and storing.

So that is a rather, in my opinion, successful program for BWR fuel assemblies. That program starts this year and has most of its activity in fiscal year 1983.

We also have a cooperative program with Florida Power & Light wherein we take PWR fuel elements, about 15 percent of a reactor core, and also provide cask storage and demonstration.

Again, our costs there are on the order of $800,000 to $900,000 and that program will have its major activities in fiscal year 1983.

With those two programs, which include license applications to the NRC for dry cask storage, we will be making a substantial contribution to the solution of the spent fuel storage problem.

Mrs. BOUQUARD. What do the utilities contribute to these projects?

Mr. COFFMAN. They are contributing the major portion of the cost. They will be responsible for providing the fuel, the facility for the rod consolidation and compaction, the loading, and the site.

So most of the costs are borne by the private utilities. Our part is limited to providing a cask, in the case of TVA, and supporting some of the paperwork associated with the license application.

Mrs. BOUQUARD. I have other questions, but I would like to recognize Mr. Lundine this morning. Welcome to the hearing.

Mr. LUNDINE. Thank you, Madam Chairman. I want to follow up on what you were just talking about. I appreciate your recognizing me.

What is the total amount that you are proposing to spend in fiscal year 1983 on these dry storage research projects?

Mr. COFFMAN. There is approximately $2 million associated with those two projects.

Mr. LUNDINE. So your basic spent fuel R. & D. program will continue, and you don't propose to interrupt it in terms of the progress we can make toward possibly using that as one technology to deal with the reactor storage program?

Mr. COFFMAN. No, sir. We believe that dry cask and dry well storage represent very viable options for ameliorating the problem of the excess spent fuel that is accumulating at some of the selected reactor sites. It appears to have competitive economics and it has the advantage of being able to be constructed and licensed in a modular fashion in accordance with excess fuel demand, and it also has shorter construction times than, for example, building a large add-on fuel basin.

So we are very supportive and propose to continue that program.

Mr. LUNDINE. I don't want to give you the impression that I evaluate everyone's effort by how much money you are spending on the program, but it was my understanding that last year, you spent approximately $7 million on this program.

I am concerned. If you are only spending $2 million, are you really making as rapid progress toward meeting the date in the mid-1980's when some of the utilities are going to be experiencing real problems with the capacity of their pools at the sites of their reactors?

Mr. **Coffman**. Well, we are pretty much on schedule on that. In the area of fuel storage assessment and general technology support, such things as rod consolidation and the SAR and licensing support that go with that, we are proposing about $1.5 million in fiscal year 1983.

We had a small $400,000 study working jointly with the Japanese in what is called the Pacific Basin study.

We have $1.7 million in the development of fuel integrity and performance associated with dry cask storage, and we have about $1.8 million in the generic fuel performance data.

This is only for the large-capacity storage casks. When I was referring to a little less than $2 million, I was referring to these two projects.

Mr. **Lundine**. Just the TVA and the Florida project?

Mr. **Coffman**. Yes, sir. So we are continuing that at roughly a level of effort.

Mr. **Lundine**. I am delighted at your optimism and I share your hopeful attitude about the dry cask storage.

Mr. **Coffman**. The fiscal year 1983 proposed work is $7.4 million, so the total program is continuing. We do have the continuity.

Dr. **Dillon**. I think the technology part itself has been very successful in both the rod disassembly, compaction and dry cask. One area we are obviously concerned about is whether the NRC licensing of those technologies will be timely when the problems arise in 1986 and 1987.

Mr. **Lundine**. Exactly. I was delighted to hear that one of your components in this program is to work on the licensing because I think it is crucial. I would like to turn to a related subject. This whole matter of monitored retrievable storage.

First of all, I would like to ask you, what is that? I really don't understand what is meant by monitored retrievable storage.

Dr. **Dillon**. What I can tell you, Mr. Lundine, is our concept in the Department of Energy of what a monitored retrievable storage facility would be and how it would fit into our waste program. We look to a day in the backend of the fuel cycle when there will be reprocessing and we will be generating not only spent fuel but reprocessed, high-level wastes, which will be solidified into logs.

The flow of that material will be quite large. In terms of the amount of spent fuel generated annually by even our current capacity of about 59,000 megawatts—and that will grow steadily during the 1980's—we produce a tremendous tonnage of material every year.

If we go into reprocessing we expect to produce a tremendous tonnage. If there is an interruption in operation of a waste repository or delay in putting a waste repository into operation, we want to make sure we have a surge capacity or a capability on an interim basis to receive those wastes and perhaps some unusual forms of spent fuel, and store it temporarily until the repository is operating.

It is frequently confused with an AFR, but we think of it very much more in the context of effective operations of a waste repository system in conjunction with reprocessing.

Mr. **Lundine**. It is not an answer to the interim mid-1980's problem?

Dr. **Dillon**. No, sir. The other thing we feel very strongly about, it is not an answer to the disposal problem either.

Mr. **Lundine**. Right.

Dr. **Dillon**. We see it in conjunction with, and as a complementary part of, geological disposal and not a stand-alone solution.

Mr. **Lundine**. Is this a concept ready to be implemented or do you need considerable additional research?

Dr. **Dillon**. I think the conceptual design activities we propose in the 1983 budget will give us a much better handle on that question. We are not sure exactly whether or not additional research needs to be done or what kind of problems would be involved in constructing and licensing such a facility. That is why we proposed we do the conceptual design work in 1983.

Mr. **Lundine**. Conceptually, do you have any opinions whether it would be colocated at the site of a repository or not?

Dr. **Dillon**. Probably it would be colocated at the site of a reprocessing plant or a repository for the following reason. Transportation costs are not trivial when you talk about total disposal and storage costs. You don't want to be shipping spent fuel elements or solidified high level logs back and forth across the country.

So, when you consider the overall economics, probably the most attractive siting location would be at a reprocessing plant or a repository site. Again, that is something which would have to be decided in the context of the overall system.

Mr. **Lundine**. I understand that, but I appreciate your candor. There is just one other question on that subject that you raised with me and I am having trouble on how to phrase it.

Can you quantify the amount of storage space it would take if we were not going to reprocessing, and if we were just to bury spent fuel rods in a repository, versus the amount of solidified high level waste that there would be if we do have reprocessing? Is essentially what we are putting in the ground in a repository just the solidified high level waste?

Dr. **Dillon**. As you know, in reprocessing there is a tremendous reduction in the volume of the high level waste. What we plan to do is then put that high level waste into a glass matrix, vitrify it, then the volume comes back up again. The bottom line is that in terms of the actual volume, probably there is not too much difference between the volume that would be used for reprocessed high level waste and the volume that would be used for spent fuel in a repository because the design of a repository is based on two fundamental criteria, the heat load or the amount of heat given off, and the radiation load or the effect that would have on the environment. But thermal loading is the most important.

Basically you have to design the volume of a repository to account for that much heat. The advantage, and there is a big advantage we feel, to disposal of reprocessed high level waste in addition to all the advantages of reprocessing is that it is an intrinsically easier quantity to define. More than that, it can be engineered. So, we can basically modify reprocessed high level waste into virtually any concentration or density we want in order to optimize the operation of our repository and its licensing.

So, it is a more homogenous, easier to characterize medium which is an advantage in licensing. And it is something which can be tailored, whereas with spent fuel rods, there are more limitations on what you can do.

Mr. **Lundine**. Turning to West Valley, I would like to first of all say that I am not a nitpicker but I am interested enough in West Valley that I want to point out that page 26 of your written testimony was omitted. You really just got me interested, and then the last page on West Valley was not there. I would just appreciate getting it at some point in time.

When will you decide the waste form that the solidified waste will take?

Dr. **Dillon**. We will decide it shortly in the context of 1983 but I would like Frank Coffman to talk to the details of the technical program there.

Mr. **Coffman**. We hope to get the environmental statement out for the project within the next few months. Our milestone was March or July. We are proceeding now with the analyses on waste form options. We are very optimistic that borosilicate glass will be the waste form and hope to confirm waste form selection certainly by 1984, and hopefully much sooner.

Mr. **Lundine**. What basically can be achieved with the $15.4 million you recommend for fiscal year 1983?

Mr. **Coffman**. Well, a good portion of that money will be used to maintain and restore the facility to a fully operational status. We will make sure the fences are fixed and that the guard gates operate satisfactorily. But a substantial fraction will be committed to doing the detailed design of the glass making plant, tracing the lines and pipes as a basis for starting the decontamination effort.

We will begin some actual decontamination effort in some of the peripheral areas of the reprocessing building. It is our intent to focus very strongly on getting the baseline design completed. That requires us to select the waste form in the next 2 or 3 months in order to proceed in a mission-oriented way and to get a firm handle on the TEC and proceed with the project.

Mr. **Lundine**. You can do that, you can select the waste form without knowing the design of a repository where it will be shipped?

Mr. **Coffman**. I think that is true. In the defense programs area, and at TMI and at West Valley and in our repository R. & D. program, we are looking at waste forms. The data to date leads us toward borosilicate glass for all those program options without knowing the specific repository designs. I personally am rather confident we will make that selection in the next 3 months.

Mr. **Lundine**. How difficult will it be to get the liquid out of a tank? As you know, some people in western New York are very concerned about that process.

Mr. **Coffman**. In this particular case there is a rather broad experience base vis-a-vis the defense programs. There are extensive tank farms at Hanford and Savannah River. Their basic program for the last 6 or 8 years has been to sluice out and evaporate down and reduce the volume of wastes. The clear water fractions should come quite easily, but there is a tarlike fraction in the tanks which may pose problems. The more we shall try to remove the sludge and sluicing of the organic polymers on the bottom.

But, that has been a problem that has been worked on in the defense programs now for over 5 years, and on and off for the last decade.

So, I feel confident we can do that. Of course, the question will be how clean can we scrub the tanks down.

Mr. **Lundine**. Can you give some idea as to when that will happen?

Mr. **Coffman**. We are having a rather intense internal review, trying to minimize the schedule time and minimize the total estimated cost. We have a 90/10 cost sharing arrangement with the State of New York. And all parties concerned want to have a strong demonstration of the waste solidification technology.

But, on the other hand, we want to remove the waste from those tanks as quickly as we can and put them into an immobilized form. It will take us realistically about 6 years including a conceptual design period. If we begin now and aren't limited by funding restraints, in about 6 years I think we can be in a position to start shakedown on the glass making plant.

Mr. **Lundine**. Do you envision you would use any of the existing plant for glassification?

Mr. **Coffman**. It is our intent to the extent practicable to avoid constructing any new office buildings or process buildings.

There are 80,000 square feet in that facility, and if we had to build another facility, that would just be two facilities to eventually decontaminate.

So, I am personally very optimistic that we can decontaminate and refit the main process cells and utilize the existing plant; but a final decision will be made in the next 3 months.

Mr. **Lundine**. Thank you very much for your patience, Madam Chairman.

Mrs. **Bouquard**. Thank you very much, Mr. Lundine.

Has DOE informed the EPA and the various possible users of the availability of the sewage sludge irradiation technology; and if so, have they been receptive to application of this technology, Gordon?

Mr. **Chipman**. Yes, Madam Chairman. They have been informed, and they are aware of the potential users. They seem to be interested. I am not certain, exactly, how they are using the information, however.

Mrs. **Bouquard**. But have they been receptive to that concept?

Mr. **Chipman**. I would have to say a qualified yes on that. We have informed the users of the technology available. I cannot tell you now the particular process.

Mrs. **Bouquard**. Have you encouraged them as well?

Mr. **Chipman**. Yes, I would say we have.

Dr. **Dillon**. That was done in conjunction with the demonstration exhibit in Albuquerque. That was a joint program with the EPA who we see as a possible strong ally in picking up this activity and taking it forward.

It remains to be seen exactly how much interest will develop. I know they have budgetary restraint problems also.

Mrs. **Bouquard**. We will be following how receptive the users are and the amount of money spent in this area, is that correct?

Dr. **Dillon**. Yes.

Mrs. **Bouquard**. Turning to our safety technology program, do you expect new R. & D. initiatives to come out of the 10 working groups you established to develop a comprehensive safety program in response to Public Law 96-967? I am very concerned about this.

Dr. **Dillon**. We think new initiatives in terms of safety R. & D. are bound to come out of those groups. We expect also identification of overlaps and redundancies. Our objectives in carrying out those working groups are coordination, sorting through, and prioritizing the relative importance of the various activities. I would be surprised and somewhat disappointed if that activity came up with just a continuation of the status quo.

So, we are expecting and hopeful to find both new initiatives and opportunities for savings to come out in terms of the R. & D.

Mrs. **Bouquard**. Where would you say there was an overlap, Tom?

Dr. **Dillon**. I hesitate right now to prejudge any specific areas, but in working not only with industry but with NRC, we have found areas where we are not sure everybody is as coordinated as they could be. We have found a lot of willingness in terms of the academic community, industrial and NRC research communities to take part in these working groups. I think their willingness to commit resources to those working groups is, in itself, a manifestation that they see we could profit from this kind of coordination.

Mrs. **Bouquard**. I was looking at the budget and was really concerned how you plan to have a comprehensive program in this area when you scale the funding down over 90 percent from last year's budget.

Dr. **Dillon**. Definitely.

Mrs. **Bouquard**. I was very concerned about it.

Dr. **Dillon**. It is not a continuation of the safety R. & D. program. That will, if appropriate, come out in the 1984 timeframe. We are required to report to the Congress annually with a safety plan and show what the budget does to reflect that.

Mrs. **Bouquard**. That is what I was concerned about, that you were going to report on the framework and activities that have been conducted.

Dr. **Dillon**. Yes; it is not a decision to terminate the safety R. & D. program. It is reducing it for a year while we carry out these working groups. Then we will have to evaluate our findings in the context of developing the fiscal 1984 budget.

Mrs. **Bouquard**. I think you are all aware that this committee is very concerned about this commitment in this area.

I am aware you are engaged in negotiations with DARPA and NASA on the issue of developing an appropriate management plan for the triagency agreement on the SP-100 development program.

What is DOE's perception as to the appropriate roles for each of these agencies?

Dr. **Dillon**. I would like to ask Gordon to answer that. He has been carrying out these negotiations with NASA and DOD.

Mr. **Chipman**. A historical background would perhaps be useful before I try to give specific answers. You may recall the Department of Energy and its predecessors, AEC and ERDA, have been involved in a number of joint programs in the reactor development area with a number of other agencies including NASA, the Department of Defense, and the Navy, with the naval reactors program. These have all been very successful programs operated with joint staffs in many cases and under DOE auspices and control.

We believe that the space reactor program can very successfully be operated in this same manner. Discussions to date with NASA have indicated that there is an interest in splitting up the responsibility between the reactor development and the power conversion development.

In the past, DOE has generally covered all aspects of the system. However, NASA now is showing an interest in doing the power conversion system. We believe we can work with that arrangement. We have a very strong capability in the power conversion arena ourselves. If the capability of NASA to do that part of the work meets their program needs, we think it is feasible to operate in that way.

To date, the thinking and the organizational structure is one where, from the DOE point of view, we would maintain control of the reactor development program, but be working through some kind of joint program office.

Mrs. BOUQUARD. Who will have the basic management oversight responsibilities?

Mr. CHIPMAN. That is an issue we are still trying to resolve. The concern the Department has is the legislation that has authorized the whole nuclear program from day 1. The Atomic Energy Act and then the Energy Reorganization Act placed DOE in the responsible position for dealing with nuclear technology. That, in fact, is why these program offices in the past have been centered at the Department of Energy or its predecessor agencies.

Mrs. BOUQUARD. I know the budget request realigns about $2.5 million from your RTG development activities to the SP-100 project. What is the impact of this decision on the Galileo flight schedule?

Mr. CHIPMAN. As indicated, we have been looking at the impact of that. We have concluded that under the strict interpretation of the budget as proposed we do have problems in meeting the solar polar and Galileo schedules. We are working with NASA now trying to resolve our funding difficulties.

Mrs. BOUQUARD. What is the position of NASA with regard to these funding priorities?

Mr. CHIPMAN. NASA, of course, would like to see Galileo and solar polar meet their mission schedules. They are very interested in us meeting our schedules and supporting them. We both are having funding difficulties, as I think you can imagine. Neither is really volunteering to come up with the money from another program.

As you know, the Department of Energy budgets have been rather severely impacted in 1983.

Mrs. BOUQUARD. I am well aware of that fact. That is one thing we can all agree on.

Let's go over to Barnwell. We are covering a wide range of territory today. I was really concerned about the basis for the administration's position on Barnwell, specifically.

The appeal for a utility takeover was reenforced while at the same time DOE is asking for $10 million for 1983. Just where are we?

Dr. DILLON. When the President made his decision that we would pursue commercial reprocessing with financing from the utilities or commercial sector, he also instructed us to look very closely at what are the regulatory barriers and other barriers that have resulted from Government policies that would not foster such investments. And we have done that. And one of the things that certainly has emerged as a recurring theme—and there are several problems with regard to private investment in reprocessing at this time—is an uncertainty about the handling of plutonium, specifically what Government policies will be, what the specifications will be, the criteria for handling plutonium, and safeguards.

The R. & D. activities we are sponsoring at Barnwell go directly to that core issue. And we feel that Government R. & D. activities dealing with some of these fundamental issues that are technical and that they have a bearing on a utility or commercial firm's willingness to invest in reprocessing are bona fide activities to engage in.

They are not in any way intended to be the beginning of a decision——

Mrs. BOUQUARD. I really want to know what $10 million is going to do at Barnwell.

Dr. DILLON. We will use it to operate the plant, test out the systems, verify these overall control systems will give us a viable way to control plutonium in the reprocessing cycle, and develop the specific kinds of criteria that would be the basis for Government regulation of that.

Hopefully, by clarifying that, we will resolve some of the concerns. And, I have to admit, that is just one step, but it is an important one and it is one that is probably amenable to Government actions. That is why we would like to carry out that program.

Mrs. BOUQUARD. What plans does DOE have for closing the back end of the fuel cycle?

Dr. DILLON. Our plan for closing the back end of the fuel cycle is to do everything possible to encourage commercial reprocessing. Other than that, I think the next big step is to move very aggressively on the waste program. Clearly, getting a waste repository licensed and in operation is one of the highest priority nuclear program elements. I think that if we were successful in those two areas, which is to establish commercial reprocessing and to carry out the waste management program that we described earlier this morning, I think that for all intents and purposes we would have closed the fuel cycle and we would be providing a future basis for a breeder economy.

So, those are the two principal policy elements associated with closing the fuel cycle. One is a private responsibility. The other is very much a Government responsibility.

Mrs. BOUQUARD. Do you really believe that any firm or utility would be interested in buying Barnwell?

Dr. DILLON. It would be a very difficult decision at this time, certainly, for any single firm. As we have studied the problem, we have become aware of the practical investment problems.

Mrs. **Bouquard**. Do you think it is a political problem?

Dr. **Dillon**. I think there is a political element of course, but I think——

Mrs. **Bouquard**. Lack of stability of an ongoing program?

Dr. **Dillon**. I think that is a very big concern that emerges. It is somewhat of a financial problem, too, particularly for a single firm to make the investment at this particular time in the development of the nuclear industry.

So we have the financial problems that the utilities or consortia of utilities would have to face, a very serious concern about the stability of Government policies, and the impact it could have on the viability of those investments.

Mrs. **Bouquard**. I want to go back on a question Mr. Lundine touched on briefly on our waste disposal. It was my understanding that reprocessing would simplify our waste disposal problem.

Dr. **Dillon**. It does simplify it. He was asking a specific question about volume. It is my belief that reprocessing creates a substantial reduction in the volume of the high level waste. But when we go with the kinds of vitrification options, putting it into the glass matrix, a lot of that volume comes back.

So, I think there will be a small volume advantage due to reprocessing and then vitrification. But the key advantage is, you used the perfect word, simplification, because it is a homogenous material, one that can be characterized, in effect, engineered or tailor made to our requirements. Having reprocessed high level waste simplifies our job of not only designing and constructing a repository but licensing it. It is easier to characterize a waste form that you have engineered and tailored than a waste form which is a little bit more difficult to characterize uniformly, like spent fuel rods.

Mrs. **Bouquard**. But in addition to the size factor, I was referring also to the background radiation levels as much more desirable from that standpoint also.

Dr. **Dillon**. I think it is very desirable because the amount of transuranic materials, plutonium and, in fact, the uranium, that is removed is enormous. And I think that by taking the vast bulk of the plutonium and uranium out of the spent-fuel elements, there are substantial advantages in terms of not only the public safety and health, but possible future security implications too.

So, there are lots of advantages to reprocessing. I am not really aware personally—and I could ask Frank—of any disadvantage to reprocessing. There is a whole series of pluses associated with using reprocessed high level waste. But from the waste disposal point of view I am not aware of any disadvantages.

Mr. **Coffman**. No, I can't think of any. The fundamental disadvantage of not reprocessing from my perspective is the thought that the irreversible disposal the tremendous uranium and plutonium energy content and is, in the long term, not to the benefit of this Nation.

From my perspective——

Mrs. **Bouquard**. I share your conviction, certainly.

Mr. **Coffman**. That is the driving force. If you look at this country we have 40 percent of the world's supply of uranium. For LWR applications that uranium represents energy content which is some one-half times the entire Middle East oil reserves.

Mrs. **Bouquard**. Couldn't it in reality be 90 percent of our energy supply?

Mr. **Coffman**. That is also true as I understand it. So I think it is not wise for this country, in the long run, to fabricate uranium and run it once through a reactor and then dispose of it, wasting those rather tremendous energy reserves.

That is the context in which I strongly support reprocessing, as an integral part of closing the back end of the fuel cycle.

Mrs. **Bouquard**. Thank you very much. We will go to the HTGR now.

Looking at your budget, you stated that there was no request for funds because "a commitment had not yet been achieved." What funding would have been requested had a commitment been received?

Dr. **Dillon**. I think that the budget narrative might have been a little misleading. The lack of a commitment from utilities for a lead plant was just one of many factors involved in the decision. The decision not to request funding for the HTGR was made in the overall context of budgetary restraint. It was made, I think, primarily in a context of a very slow market for nuclear reactors in general.

The real key issue that was at stake with regard to development of the HTGR budget this year, is the commercial viability aspects. The Fort St. Vrain plant continues to operate, and it went to full power as I said. We are, I think, stressing more the commercial viability.

If a firm commitment were to come for a lead plant by a specific lead utility, and there was an acceptable funding package, I think that then there might be a reevaluation of the administration position. But I certainly wouldn't be able to identify any specific funding request.

Mrs. **Bouquard**. You are indicating that there is an overall soft market for reactors. I would like to ask you some questions about the HTGR program on the basis that the program will continue. Let's put it in that context, then, if you will.

How will the 29 supporting utilities interface with the program activities? In other words, is there going to be a single voice, that of the Gas-Cooled Reactor Associates, or will GCRA individual utilities have approval/disapproval rights?

Dr. **Dillon**. Well, I think that we have an understanding of what the Gas-Cooled Reactor Associates are proposing in terms of their concept for proceeding.

Mrs. **Bouquard**. Some of these utility companies are at times rather conservative. Some delays in making a decision could have an impact on the program.

Dr. **Dillon**. Yes.

Mrs. **Bouquard**. Would you like to comment on that, Gordon?

Mr. **Chipman**. I would second what you just said about conservatism in the industry, and it could have an impact. I think, for a number of reasons, we have seen that the lead plant proposal has not come forward yet. Many of these are economic in nature. There are a number of problems that the utility industry is facing. But there is clearly a large interest out there in this technology proceeding. The question is, Is the industry ready to put its money in there? That is not clear.

The program we currently have, Madam Chairman, is controlled. The funding is from the Department of Energy in fiscal year 1982 and previous years. It is controlled by the Department, with interaction with our contractors, which includes GCRA, AI, and others.

For the lead plant project itself, the proposal that comes in will, in fact, make a specific recommendation on how to proceed. We will then go through a process similar to what we are going to try to do on the large development plant in the breeder area—of sorting out exactly what role each of the parties is going to play. Clearly, the Federal Government has not made any commitments nor is there any clear definition of precisely what role it would play at this time.

Mrs. BOUQUARD. Will the Gas-Cooled Reactor Associates be the spokesman, or are the individual utilities going to speak individually? How do you see this falling in line?

Mr. CHIPMAN. Well, I don't have the specifics on that. I can tell you that whoever the utility customer is, is going to play a major role in it. Gas-Cooled Reactor Associates is also going to be an active partner.

Exactly how it will be controlled, I can't tell you.

Dr. DILLON. One of the ideas that I think will be proposed by the industry will have a concept of an industry steering group, with representation by DOE and other concerned parties, that would have general oversight for a lead project reporting directly to a utility. That is my understanding of the proposal that they would come up with.

In terms of the administration's position that this should be a private initiative, and privately financed—certainly, we wouldn't expect, under those circumstances, for DOE to be—to play a major or predominant role in management. That basic structure would be the appropriate one.

Mrs. BOUQUARD. Would you identify the portion of the 1983 advanced nuclear systems program budget request that is to perform for NASA and other agencies? What I am really getting at, how much of the program's activities are reimbursed by other agencies?

Mr. CHIPMAN. Did you say 1982 or 1983, ma'am?

Mrs. BOUQUARD. Fiscal year 1983.

Mr. CHIPMAN. The RTG work, radioisotope thermal electric generators being produced for the solar polar and Galileo missions in 1983 is about $25 million. That is DOE money. NASA is reimbursing us $5 million as proposed in the 1983 budget.

In the space reactor arena DOE is proposing $2.5 million in 1983, with NASA contributing $1.3 million and perhaps the Department of Defense, $1 million. In the sludge area in 1983, as you know, the nuclear energy program in the Department will not be participating, but defense programs will support that to the $2.5 million level.

Mrs. BOUQUARD. Gordon, I think you are aware that last year this committee requested that there be a more equitable funding split than this; that really, more money should come from the other agencies. What is DOE's recommendation of an equitable funding level? It seems to me that DOE is still paying a disproportionate load of the burden.

Mr. **Chipman**. Historically, the program has been set up such that the DOE and its predecessor agencies have done the basic R. & D. and developmental work. When it came time to produce the units for the flights, then reimbursement was made by the end user—in this case, NASA.

Last year the committee wrote in its report that the historical practice of the Department of Energy paying for the qualification and spare flight units should no longer stand, and that these should also be reimbursed by NASA. We are working with NASA now on that very issue for the fiscal year 1983 time period.

In fact, if NASA does increase its reimbursables in 1983, that could cover our shortfall.

Mrs. **Bouquard**. I really wish you would look into this reimbursement issue. With respect to this, what additional resources are required to meet the present hardware delivery schedules for the Galileo and ISPM power sources?

Mr. **Chipman**. We believe we need a minimum of $5.3 million in 1983 to meet these schedules.

Mrs. **Bouquard**. Thank you. What is NASA planning to contribute?

Mr. **Chipman**. The 1983 contribution, is as I said, currently scheduled at $5 million. The additional contribution that would be required from NASA to fully reimburse DOE for the qualification and spare units in 1983 would be an additional $8 million.

However, we have a funding shortfall that is only $5.3 million.

Mrs. **Bouquard**. Thank you very much. It is my understanding that the minority has questions that they would like for you to respond to. They will be submitted to you in writing and we would like your responses to be made a part of the record.

Thank you very much for being with us today. If there are no further comments the committee will adjourn at this time. But our hearings will resume in the morning. We will meet to continue the discussion of the DOE fission programs. We will meet in 2318 tomorrow at 1 o'clock. We will hear from outside witnesses. Thank you so very much for being with us today.

The subcommittee is adjourned.

[Whereupon, at 10:15 a.m., the subcommittee adjourned, to reconvene at 1 p.m., the following day.]

FISCAL YEAR 1983 DEPARTMENT OF ENERGY BUDGET REVIEW

WEDNESDAY, MARCH 17, 1982

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met, pursuant to notice, at 1:02 p.m., in room 2318, Rayburn House Office Building, Hon. Marilyn L. Bouquard (chairman) presiding.

Present: Representatives Bouquard, Hollenbeck, Volkmer, and Lowery.

Mrs. **Bouquard**. The subcommittee will come to order.

Before we begin, I ask unanimous consent that, pursuant to House rules, television and other recordings of today's hearings be permitted. Without objection so ordered.

Good afternoon, ladies and gentlemen. Today the subcommittee will continue its revew of the Department of Energy's nuclear fission R. & D. for fiscal year 1983. The particular subjects for discussion cover a wide range of topics.

I think it is only fitting that we begin this St. Patrick's Day hearing with our old friend, John Conway.

Welcome, John.

Mr. **Conway**. Thank you, Madam Chairman. I was surprised that you held the hearing on a national holiday.

Mrs. **Bouquard**. You know we had to go on with the Nation's business. [Laughter.]

Mr. **Conway**. Yes, ma'am.

Mrs. **Bouquard**. John will review the industry position on nuclear waste legislation which we have great hopes of moving this year.

We will follow the waste testimony with a presentation by Dr. Kerrebrock from NASA on the DOE/NASA programs in advanced nuclear systems. As I mentioned in my opening remarks at yesterday's hearing, this activity provides the low power—less than 1 kilowatt—radioisotope thermal generators for the Galileo and international solar polar missions. It also supports the development of a higher power—of the order of 100 kilowatts—space nuclear reactor that will serve the deep-space exploration, as well as defense-related missions of the 1990's.

The subcommittee will want to look at the effect of proposed funding reductions on these activities. We will also want to determine whether or not the funding support provided to these programs by the user agencies is appropriate to the level of effort required to complete the tasks.

Next on the agenda, a panel of distinguished industry witnesses will review the status of the high-temperature gas cooled reactor, or HTGR. We have Dr. Agnew, Dr. Walker, and Dr. Richards. They are also well known to the committee, and we are happy to have them here today.

This HGTR technology has been advocated by this subcommittee for the past several years. It offers certain unique safety features such as the graphite core and the stability of the ceramic fuel at high temperatures and represents the only end-use application of nuclear energy for process heat.

The Department of Energy has made no request for funds in fiscal year 1983 for the gas cooled reactor. It is my conviction that the work accomplished so far should not be lost and the HTGR concept must be developed according to a stable plan to build industry confidence.

We will close the hearings with a consideration of the Department's requests for light water reactor programs, the extended fuel burnup subprogram and some general issues related to nuclear safety research and development. These programs have been substantially reduced in scope in fiscal year 1983. I am concerned about these reductions, and I hope that our discussions today will assist the subcommittee in understanding their effect on the nuclear industry.

At this time I do want to welcome our first witness, Mr. Conway.

We have your testimony and you may proceed as you wish. Your testimony will be made a part of the record.

Mr. CONWAY. Thank you, Madam Chairman. And I was going to request that I would submit the statement and it be introduced in the record as if read, and I would just make a few comments and be responsive to any questions the Chair may have.

Mrs. BOUQUARD. Please proceed.

STATEMENT OF JOHN T. CONWAY, PRESIDENT, AMERICAN NUCLEAR ENERGY COUNCIL

Mr. CONWAY. In the opening part of my prepared statement I try to put in perspective the proportion of money that is being designated nuclear as compared with other energy sources in this year's proposed budget. We have heard testimony and statements made by others that nuclear is receiving a disproportionate share—and we have seen figures between 60, 70, or 86 percent alleged to be allocated of the budget to nuclear. In my statement I try to put in perspective and show that to get those high figures, actually, one has to include items that are part of the Government's space program and part of its military program. And if you really get down to the nuclear—commercial nuclear—field it is a relatively small amount of the budget, and actually it falls somewhere in the order of 34 percent. And that actually is a 25-percent reduction when compared with last year's budget.

So we in the nuclear field, I would respectfully submit, are also taking cuts from this administration, and the figures that purport to show 60- to 80-some-odd percent are actually misrepresentations.

And so, I try to put that in perspective at the beginning of my paragraph.

I have been asked to put my emphasis on the nuclear wastes and the nuclear wastes field. In that regard, I would like to tell you how thankful we are for the action of this committee.

This committee has taken the initiative and the lead in putting forth waste legislation. Your bill—you have reported out H.R. 5016—we strongly support. We thank you and the other members of this committee for recognizing the importance the waste legislation should be receiving from this Congress, and we would hope that you could encourage other committees of Congress, in both Houses, that have jurisdiction in this field to take action and follow the lead that you have already demonstrated.

We have sent a letter to every Member of the Congress, a letter that has been signed by the heads of over 70—actually, 76—utilities in the country, representing those companies that are involved in the production of electricity in which we are using nuclear power, and supplying over 160 million customers. Those utility heads have written to every Member of the Congress requesting that action be taken in this Congress this year in putting forth waste legislation, and I respectfully request that a copy of that letter, which is attached to my prepared statement, be included in the record as you publish it, please.

Mrs. BOUQUARD. Without objection, it will be made a part of the record.

Mr. CONWAY. Thank you.

I might also call attention, if you haven't seen it, in yesterday's Washington Post, to the full-page ad which reproduced that letter with the 76 signatures identifying each of the individuals, again bringing attention to the Congress and to the public what we believe to be the, if not the most, one of the most essential pieces of legislation that's required by this Congress. And we certainly will do everything in our power to assist those members of your committee and other committees that are attempting to get legislation through to see if we cannot get something through this year.

[The prepared statement of Mr. Conway follows:]

STATEMENT
BY
JOHN T. CONWAY
PRESIDENT
AMERICAN NUCLEAR ENERGY COUNCIL
BEFORE THE
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
COMMITTEE ON SCIENCE AND TECHNOLOGY
U. S. HOUSE OF REPRESENTATIVES

March 17, 1982

My name is John T. Conway. I am President of the American Nuclear Energy Council -- a nuclear trade association located in Washington, D.C., with a membership of over 100 organizations including private, public and cooperatively owned utilities, manufacturers, architect-engineers, uranium mining companies and various other firms engaged in the nuclear fuel cycle. The Council supports energy conservation and the development of synthetic fuels, solar, fusion and other longer range energy resources, but holds that nuclear power is essential if this Nation is to have adequate and dependable electrical energy supplies throughout this century.

John T. Conway formerly was Executive Assistant to the Chairman of the Board, Con Edison, New York, for 10 years. For eight of those 10 years he was Chairman of the Nuclear Facility Safety Committee which had overall safety responsibility for Indian Point Units 1, 2 and 3. He has a BNS and BS in Engineering from Tufts College of Engineering and an LL.B. from Columbia University School of Law. From 1956 to 1968 he was on the staff of the Joint Committee on Atomic Energy, U.S. Congress.

Madame Chairman and Members of the Subcommittee, I am pleased to appear before you to discuss the FY83 nuclear fission energy budget and, in particular, the nuclear waste program. I should like to begin by attempting to put the FY83 nuclear budget into proper perspective.

FY83 Nuclear Budget

Some concern has been expressed that a disproportionate share of DoE's budget is being allocated to nuclear energy. In recent hearings, claims have been made that somewhere between 67% to 86% of DoE's budget is allocated to nuclear.

To the extent that these percentages are being cited to demonstrate that civilian nuclear energy is receiving an unfair share of Federal research and development funds, I believe them to be misleading because they include, under the heading of nuclear, certain projects that are related to the government's outer-space and military programs. For example, funds allocated to the Advanced Nuclear Systems ($31 million) directed toward the government's space efforts and Remedial Action to clean up military related mill tailings ($50 million) should not, in our opinion, be characterized as civilian nuclear energy programs. In addition, funding for fusion, a desirable program, should not be identified with the commercial nuclear energy program.

Recognition also should be given to the fact that $185 million earmarked for the nuclear waste fund is to be repaid directly by the industry.

Subtracting these elements from the nuclear total yields a more accurate sum for the civilian nuclear program of $750 million, which represents 34% of the $2.2 billion energy R&D budget. This sum represents a 25% reduction from the comparable FY82 total of $1.0 billion (again excluding Fusion, Advanced Nuclear Systems and Remedial Action).

Thus, nuclear energy has sustained a significant cut this year and is a much smaller percentage of the energy R&D funding than the critics maintain. It must also be remembered that for the period 1977 to 1981, the nuclear fission budget declined 15.4% in year of budget dollars, or by 42% in constant FY81 dollars. Finally, it should be pointed out that outside the R&D funding category, other energy sources enjoy government assistance in the form of tax credits, health benefits, depreciation allowances, and so forth.

Madame Chairman, today nuclear energy is providing approximately 12% of our country's total electrical supply (see Attachment I). This year it is projected to become the second largest generator of electricity, surpassed only by coal. By 1990, as additional plants in the pipeline begin operation, its contribution will increase to between 22% and 25%. However, nuclear energy, along with coal, can and should contribute far more to our future energy security. The nuclear option is capable of providing hundreds of years of economic electrical power, independent of foreign energy sources.

Recognition of the critical role of nuclear power in this nation's energy future was made by President Reagan in his October 8 Nuclear

Policy Statement. In announcing a series of initiatives designed to restore vitality to the nuclear industry, the President stated: "One of the best potential sources of new electrical energy supplies in the coming decades is nuclear power." We applaud the initiatives in the areas of regulatory and licensing reform, lifting the ban on commercial reprocessing, the resumption of breeder development, including completion of the Clinch River Breeder Reactor, and, in particular, the initiatives addressing accelerated development of a federal waste management program.

Nuclear Waste Program

It is our belief that, in large measure, the full potential contribution of nuclear power to U.S. energy supplies will only be realized if public confidence in the federal government's ability to resolve the waste management issue is restored. As you will note from the Public Opinion Poll shown in Attachment II, 95% of those polled consider the development of permanent sites for the storage of radioactive waste to be important. The poll also reveals that 92% agree that it is time the government moved ahead on a safe method of storing nuclear waste.

It is our view that there is enough information available to enable the Federal Government to proceed now on a conservative basis, to locate, design, construct and initiate the phased operation of a waste management system involving interim retrievable storage and final geologic disposal.

To this end, Madame Chairman, I would like to commend the Science and Technology Committee on its recognition of the public's concern regarding nuclear waste disposal and the Committee's prompt action in reporting out comprehensive legislation (H.R. 5016) to establish a nuclear waste management program. I have sent to every member of the Congress, a letter signed by the top official of 76 electric utilities and associations, which serve over 160 million Americans, requesting Congress to pass a waste bill this year (see Attachment III). We would urge the members of the Science and Technology Committee to impress upon your colleagues on the other Committees of jurisdiction the public's concern and ask for their responsive action.

In discussing any legislation concerning the implementation of a national waste management program, we believe, several important issues must be addressed:

- interim spent fuel storage;
- development schedule of geologic repositories;
- state participation; and
- financing spent fuel storage and high-level waste disposal programs.

We would now like to address these issues separately.

Interim Spent Fuel Storage

The Utility Nuclear Waste Management Group, the American Nuclear Energy Council, the Edison Electric Institute and the Atomic Industrial Forum have strongly supported the creation of away-from-reactor (AFR) spent fuel storage capacity by the Federal Government since the Carter Administration in April, 1977 "indefinitely" deferred reprocessing. Industry and the Department of Energy's own studies indicated that additional storage capacity will be necessary as early as 1986. In fact, based on data from a recent DoE survey of 67 commercial nuclear reactors, 62 were involved in expanding spent fuel storage capacity by reracking. Fifteen reactors were reracked for a second time and two reactors were undergoing a third reracking. Through 1990, there are limited options for the 26 plants which will require additional capacity. Taking into account economic, regulatory and technical considerations of the several possible options, the availability of AFRs appears to be the only assured option that would prevent the shutdown of a number of operating reactors prior to 1990 due to a shortage of storage space for spent fuel. The utilities' current spent fuel storage dilemma results directly from past government policy vacillations and government assistance is needed to solve the problem with the clear understanding that all reasonable costs will be borne by the users of waste storage facilities. In addition, the Monitored Retrievable Storage (MRS) concept would provide several important advantages in managing and disposing of spent fuel and high-level waste.

Geologic Repositories

A considerable amount of research and development work has been accomplished during the past 20 years, in solving the waste management problem. Much of the technology required to dispose of nuclear wastes has already been developed. There are no insurmountable technical problems preventing the safe disposal of nuclear wastes in a geologic repository. In fact, only political problems are preventing the timely implementation of such a program.

It is our view that the development schedule for a repository should be firm and should provide for an operating repository within a reasonable time frame.

The Administration's proposed integrated test and evaluation facility would provide early technical data on repository designs and site specific information, and would serve to demonstrate to the public that the technology exists to dispose of nuclear wastes in a safe manner. It should not be a separate program, but rather an integrated program with the site characterization activities as are permitted by the NRC's rules for licensing a geologic high-level waste repository.

To ensure that the development of the repository proceeds smoothly, it also appears that any legislation on nuclear waste management should make clear what constitutes and what does not constitute a major federal action for NEPA purposes. It is our view that the final site selection by DoE for a permanent repository should be considered the only major federal action requiring the preparation of an EIS. NRC should be required to accept DoE's EIS so as to avoid unnecessary regulatory duplication. Furthermore, streamlining of the NRC review and hearing processes for the construction and operation of a repository is also required.

State Veto Rights

There appears to be a growing consensus that institutional issues pose the greatest risk of delaying implementation of a waste management program. These issues will require Congressional action to resolve the barriers which impede this progress. Foremost among the institutional issues is the question of the proper state role in the siting of a federal repository.

States have a legitimate interest in the siting of nuclear waste facilities which must be accommodated, but must ultimately be balanced against the overriding national interest. In the previous Congress, both the Senate and the House adopted a workable procedure for states to participate in the siting of federal nuclear waste facilities, including the right to object and appeal the site designation decision to both the President and Congress. We believe this compromise procedure adopted by both Houses should be maintained in the legislative proposals now under consideration.

Financing Spent Fuel Storage and High-Level Waste Disposal

The utility industry has always agreed to be responsible for the payment of the full cost of commercial waste management facilities. Several House bills call for payments to be made on the basis of user fees associated with spent fuel storage and disposal. The Senate bill (S. 1662) contemplates another approach whereby, for permanent disposal facilities, a mandatory fee in the amount of one mil per kilowatt hour of nuclear generated electricity would be collected from utilities operating nuclear plants. If this one mil per kilowatt hour fee had been levied during 1981, the total amount collected would have been more than $250 million. By 1990, the sum of all annual fees collected would total $4 billion to $6 billion, a significant sum to finance permanent waste disposal. The development of a Nuclear Waste Trust Fund for the administration of the program would be acceptable to the utility industry due to its belief that adequate financial resources must be available in order that the waste management program can be implemented in a timely manner. Such a program would be paid for by those benefiting from the electricity provided. Indeed, the FY83 nuclear waste budget assumes creation of a $185 million Nuclear Waste Disposal Fund. It is, therefore, imperative that nuclear waste legislation be enacted early this session to prevent disruption of on-going nuclear waste programs previously funded under the DoE Budget.

If such financing proposals are to be considered, we believe the enacting legislation should authorize and direct the Secretary of Energy to enter into contracts with all nuclear power plant operators by which the government agrees by a date certain to take title to spent fuel at the reactor site.

An additional aspect of the cost of waste disposal facilities which we believe should be treated in legislation is appropriate financial assistance to state and local governments of areas affected by waste disposal facilities. This assistance should be provided to offset any direct or indirect costs incurred because of environmental, economic or other impacts resulting from such facilities. The cost of such financial assistance should be financed from fees collected from the utilities and paid into the Nuclear Waste Trust Fund.

OTHER NUCLEAR PROGRAMS

We are heartened at the President's recognition of the need to proceed with the Clinch River Breeder Reactor project (CRBRP). The Congress has repeatedly endorsed the principle that the CRBRP is a key step in the LMFBR program and that it must be expeditiously constructed to meet the objectives of the program. The previous Administration's actions delayed the project by more than five years and increased costs by more than $800 million. We can, however, pursue all possible efforts to minimize further delays in the project and costs to the taxpayer. As federal agencies involved in development and regulation of nuclear energy, DoE and NRC respectively, share a responsibility to assure that the Nation's energy future is fairly secured and that the taxpayers are well served.

Breeder reactors represent a tremendous source of energy. They can extend our uranium resources by a factor of about 60 times. The energy value of uranium already mined and above ground -- the by-product of our enrichment operations that can only be used in breeders -- is roughly equal to our total unmined coal resources or at least three times the total OPEC oil resources.

Clinch River is the right plant; it will operate at the right time; it can be built at the right cost, in the right place; and we believe the time to build it is right now.

The Congress has consistently supported High Temperature Gas Cooled Reactor Technology because of its potential to serve unique market areas that require high temperature operation. The high temperature system also offers several potential advantages, including increased energy efficiency, higher conversion efficiencies, the possibility of siting in areas now foreclosed to existing reactors and the potential for high temperature process steam and cogeneration. We support the Congress in its recognition of this technology and believe it should be funded again this year.

We should also like to take this opportunity to express our support for completion of the full 8.8 million SWU capacity of the Gas Centrifuge Enrichment Project at Portsmouth, Ohio. We believe this highly energy efficient technology will ensure the continued reliability of nuclear fuel supply to both domestic and foreign reactors at a highly competitive price.

As you are aware, the enrichment program is operated on a full cost recovery basis and this fiscal year should return to the Federal Treasury $2 billion in revenues. Not only is the provision of enrichment services internationally of value from a balance of trade perspective, but also it ensures continued U.S. influence on foreign national nuclear programs and nonproliferation policy.

With respect to the Barnwell Spent Fuel Reprocessing Facility in South Carolina, we are pleased that the FY83 nuclear budget includes funding to continue the research and development program focused on using Barnwell for reprocessing, and the development and testing of advanced safeguards systems.

Madame Chairman, this concludes my statement. I thank you for the opportunity to testify before your Subcommittee on the nuclear waste program and other impending FY83 nuclear budget issues.

ATTACHMENT I

Atomic Industrial Forum, Inc.
Public Affairs and
Information Program

December 1981

NUCLEAR POWER FACTS AND FIGURES

STATUS OF U.S. NUCLEAR POWER PLANTS AS OF DECEMBER 31, 1981

78 reactors with operating licenses[1]	59,321 Mwe[2]
74 reactors with construction permits[3]	82,308 Mwe
2 reactors with limited work authorizations[4]	2,300 Mwe
12 reactors on order	13,996 Mwe
166 total commitments	157,925 total Mwe

[1] Includes 72 reactors (55,092 Mwe) licensed for commercial operation, 1 reactor with full-power operating license (Sequoyah 2 = 1,148 Mwe), 1 reactor with suspended low-power operating license (Diablo Canyon 1 = 1,084 Mwe), and 4 reactors shut down indefinitely (Humboldt Bay = 65 Mwe, Dresden 1 = 207 Mwe, Three Mile Island 1 & 2 = 1,725 Mwe)

[2] Represents rated capability of all operable reactors and accounts for approximately 10% of the total U.S. installed electric generating capacity

[3] Stages of reactor construction completed 2 units = 0%, 25 units = 1-24%, 11 units = 25-49%, 17 units = 50-74%, 19 units = 75-99%

[4] Limited work authorization (LWA) is given by the NRC to allow limited preparation work at a reactor site prior to the decision on a construction permit. The LWA is not a NRC requirement but is requested on occasion by the utility

STATUS OF FOREIGN NUCLEAR POWER PLANTS AS OF DECEMBER 31, 1980

179 reactors operable	79,735 Mwe
160 reactors under construction	133,605 Mwe
27 reactors on order	21,285 Mwe
242 reactors firmly planned	234,904 Mwe
608 total commitments	469,529 total Mwe

U.S. NUCLEAR MILESTONES IN 1981

Electricity produced from nuclear power plants represented approximately 12% of all U.S. electrical output

Nuclear plants produced a record 285-million gross megawatt-hours of electricity, up 8.5 percent from 1980, and the equivalent annual consumption of 28-million households

Nuclear plants accumulated approximately 670 years of operating experience, or 30% of the worldwide total

During the year, four nuclear units reached commercial operation, 44 nuclear projects were delayed and 6 reactors were cancelled

U.S. REACTOR ORDERS OVER THE YEARS

Through 1965	19 units
1966	20
1967	31
1968	16
1969	7
1970	14
1971	21
1972	38
1973	41
1974	26
1975	4
1976	3
1977	4
1978	2
1979	0
1980	0
1981	0

TYPES AND MANUFACTURERS OF U.S. OPERATING REACTORS

Reactor types:

PWR	Pressurized Water Reactor	49 units
BWR	Boiling Water Reactor	26
HTGR	High Temperature Gas-cooled Reactor	1
LWBR	Light Water Breeder Reactor	1
GR	Graphite Reactor	1
		78

Reactor manufacturers:

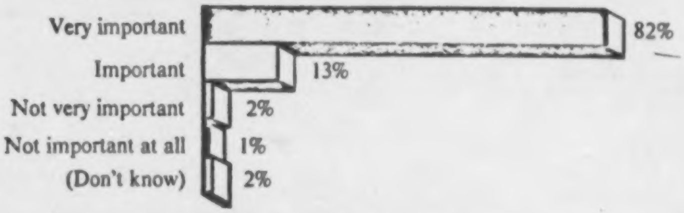
W	Westinghouse Electric Corporation	33 units
GE	General Electric Company	26
B&W	Babcock & Wilcox Company	9
CE	Combustion Engineering, Inc.	8
GA	General Atomic Company	1
AC	Allis-Chalmers	1
		78

ATTACHMENT II

Poll Shows Public Demands Government Action on Nuclear Waste

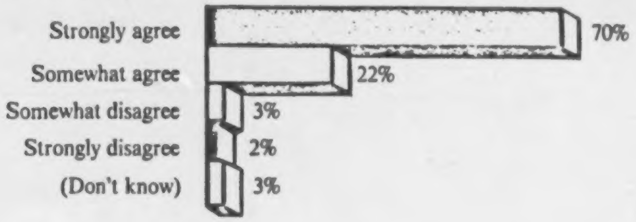
The results of a recent national public opinion survey* show that an overwhelming majority of the American people feel that it is very important for our country to develop permanent sites for the storage of radioactive waste.

How important do you believe it is for our country to develop permanent sites for the storage of radioactive waste?



Furthermore, nine out of ten Americans (92%) agree that it's time for the government to move ahead on a safe method of storing nuclear waste.

Do you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with the following statement: It's about time the government of this country stops procrastinating and starts moving ahead on a safe method of storing nuclear waste.



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* Results of a national survey conducted by Cambridge Reports Inc., Cambridge, Mass. The survey is based on personal, in-home interviews with a representative national sample of 1500 adult Americans, conducted between August 14 and September 9, 1981.

For a copy of the executive summary contact: American Nuclear Energy Council
410 1st Street, S.E.
Washington, D.C. 20003
(202) 484-2670

ATTACHMENT III

REPLY TO:
410 First Street, S.E.
Suite 300
Washington, D.C. 20003

March 3, 1982

Honorable Marilyn L. Bouquard
U. S. House of Representatives
Washington, D.C. 20515

Dear Ms. Bouquard:

This letter is being sent to you on behalf of the undersigned electric utilities and associations representing the systems now operating or constructing nuclear power plants. We serve over 160 million people in this country.

Once again, Congress has the opportunity now to enact urgently needed nuclear waste legislation establishing a comprehensive program to resolve this important national problem. We urge your support of nuclear waste legislation which contains the following essential elements:

* A separate nuclear spent fuel and waste management fund to cover the costs of storage and disposal of commercial spent fuel and high-level waste through reasonable charges to be paid as a cost of service by the electric utility systems;

* A firm time schedule and a disciplined decision-making process at all Governmental levels for the selection and construction of a permanent geologic repository;

* A program for off-site storage of spent nuclear fuel on a temporary or interim basis to assure continued operations of nuclear power plants pending ultimate disposition of spent fuel;

* Federal/state participation procedures to enhance state participation and to resolve state concerns regarding the siting of Federal nuclear waste facilities; and

* An integrated program of research and development to provide timely information needed to validate site suitability and to develop acceptable repository system designs.

The American public is growing increasingly apprehensive over the lack of a definitive national nuclear waste program -- one that can only be established by Congress. In a recent opinion poll (see enclosure), nine out of ten Americans agreed that it is time for the Government to stop procrastinating and move ahead with a program for nuclear waste management. The utilities expect to pay for such a program as a cost of providing service.

Nuclear waste legislation has been pending before Congress over the last several years. Both the House and the Senate passed comprehensive legislation in the second session of the 96th Congress, but failed to resolve their respective differences before adjournment. Nonetheless, a significant political consensus seems to have been achieved.

The respective 1980 Democratic and Republican party platforms have called for aggressive Federal action to resolve this problem. Currently, various legislative proposals are pending before the House and Senate.

Congress must not let the opportunity for passage of nuclear waste legislation slip away again. Congress must act now. Your efforts to promote passage of legislation along the lines described above would be greatly appreciated.

Very truly yours,

AMERICAN NUCLEAR ENERGY COUNCIL
John T. Conway, President

ATOMIC INDUSTRIAL FORUM, INC.
Carl Walske, President

AMERICAN PUBLIC POWER ASSOCIATION
Alex Radin, Executive Vice President

EDISON ELECTRIC INSTITUTE
William McCollam, Jr., President

NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION
R. D. Partridge, Executive Vice President
and General Manager

ALABAMA POWER COMPANY
Joseph M. Farley, President

AMERICAN ELECTRIC POWER COMPANY, INC.
W. S. White, Jr., Chairman

ARIZONA PUBLIC SERVICE COMPANY
Keith L. Turley, Chairman and President

ARKANSAS POWER & LIGHT COMPANY
Jerry L. Maulden, President

BALTIMORE GAS AND ELECTRIC COMPANY
Bernard C. Trueschler, Chairman

BOSTON EDISON COMPANY
Thomas J. Galligan, Jr., Chairman

CAROLINA POWER & LIGHT COMPANY
Sherwood H. Smith, Jr., Chairman & President

THE CINCINNATI GAS & ELECTRIC COMPANY
William H. Dickhoner, President

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY
Robert M. Ginn, President

COMMONWEALTH EDISON COMPANY
James J. O'Connor, Chairman & President

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
Charles F. Luce, Chairman

CONSUMERS POWER COMPANY
John D. Selby, Chairman & President

DAIRYLAND POWER COOPERATIVE
Frank Linder, General Manager

DELMARVA POWER & LIGHT COMPANY
Nevius M. Curtis, President

THE DETROIT EDISON COMPANY
Walter J. McCarthy, Jr., Chairman

DUKE POWER COMPANY
Carl Horn, Jr., Chairman

DUQUESNE LIGHT COMPANY
John M. Arthur, Chairman

FLORIDA POWER & LIGHT COMPANY
Marshall McDonald, Chairman

FLORIDA POWER CORPORATION
Andrew H. Hines, Jr., President

GENERAL PUBLIC UTILITIES CORPORATION
William G. Kuhns, Chairman

GEORGIA POWER COMPANY
Robert W. Scherer, President

GULF STATES UTILITIES COMPANY
Norman R. Lee, President

HOUSTON LIGHTING AND POWER COMPANY
Don D. Jordan, President

ILLINOIS POWER COMPANY
Wendell J. Kelley, Chairman & President

IOWA ELECTRIC LIGHT AND POWER COMPANY
Duane Arnold, Chairman & President

IOWA-ILLINOIS GAS AND ELECTRIC COMPANY
Dean R. Stichnoth, Chairman & President

KANSAS CITY POWER & LIGHT COMPANY
Arthur J. Doyle, Chairman & President

KANSAS GAS AND ELECTRIC COMPANY
Wilson K. Cadman, President

LONG ISLAND LIGHTING COMPANY
Charles R. Pierce, Chairman

LOUISIANA POWER & LIGHT COMPANY
Jack M. Wyatt, President

MAINE YANKEE ATOMIC POWER COMPANY
E. W. Thurlow, President

MIDDLE SOUTH UTILITIES, INC.
Floyd W. Lewis, Chairman & President

MISSISSIPPI POWER & LIGHT COMPANY
Donald C. Lutken, President

NEBRASKA PUBLIC POWER DISTRICT
D. W. Hill, General Manager

NEW ENGLAND ELECTRIC SYSTEM
Guy W. Nichols, Chairman & President

NEW YORK STATE ELECTRIC & GAS CORPORATION
Charles F. Kennedy, Chairman

NIAGARA MOHAWK POWER CORPORATION
John G. Haehl, Jr. Chairman

NORTHEAST UTILITIES
Lelan F. Sillin, Jr., Chairman

NORTHERN STATES POWER COMPANY
Donald W. McCarthy, Chairman

OGLETHORPE POWER CORPORATION
F. F. Stacy, Jr., General Manager

OHIO EDISON COMPANY
Justin T. Rogers, Jr., Chairman

OMAHA PUBLIC POWER DISTRICT
Bernard Reznicek, General Manager

PACIFIC GAS & ELECTRIC COMPANY
Frederick W. Mielke, Jr., Chairman

PENNSYLVANIA POWER & LIGHT COMPANY
Robert K. Campbell, President

PHILADELPHIA ELECTRIC COMPANY
James L. Everett, President

PORTLAND GENERAL ELECTRIC COMPANY
Robert H. Short, Chairman

POWER AUTHORITY OF THE STATE OF NEW YORK
Leroy W. Sinclair, President

PUBLIC SERVICE COMPANY OF COLORADO
Richard F. Walker, President

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE
William C. Tallman, Chairman

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
Robert I. Smith, Chairman

PUBLIC SERVICE INDIANA
Hugh A. Barker, Chairman

PUGET SOUND POWER & LIGHT COMPANY
John W. Ellis, President

ROCHESTER GAS AND ELECTRIC CORPORATION
Paul W. Briggs, Chairman

SACRAMENTO MUNICIPAL UTILITY DISTRICT
William C. Walbridge, General Manager

SALT RIVER PROJECT
A. J. Pfister, General Manager

SAN DIEGO GAS & ELECTRIC COMPANY
Thomas A. Page, President

SOUTH CAROLINA ELECTRIC AND GAS COMPANY
Virgil C. Summer, President

SOUTHERN CALIFORNIA EDISON COMPANY
William R. Gould, Chairman

THE SOUTHERN COMPANY
Alvin W. Vogtle, Jr., President

TEXAS UTILITIES COMPANY
T. L. Austin, Jr., Chairman

THE TOLEDO EDISON COMPANY
John P. Williamson, Chairman

UNION ELECTRIC COMPANY
Charles J. Dougherty, Chairman

THE UNITED ILLUMINATING COMPANY
John D. Fassett, Chairman

VERMONT YANKEE NUCLEAR POWER CORPORATION
J. E. Griffin, President

VIRGINIA ELECTRIC & POWER COMPANY
T. Justin Moore, Jr., Chairman

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
R. L. Ferguson, Managing Director

WEST TEXAS UTILITIES COMPANY
Glen D. Churchill, President

WISCONSIN ELECTRIC POWER COMPANY
Charles S. McNeer, President

WISCONSIN PUBLIC SERVICE CORPORATION
Paul D. Ziemer, President

YANKEE ATOMIC ELECTRIC COMPANY
James E. Tribble, President

Enclosure

Mrs. **Bouquard**. I want to thank you, John, for your help and for your leadership in promoting our waste bill. Certainly, it does take public participation to get any program of this scale on the right road, and we thank you for helping us in bringing it to the attention of the public that we indeed do have a waste bill and we want to move forward on this legislation in this Congress. And I thank you for your support for our bill.

Do you think that the DOE's waste program has been adequately focused on the test and evaluation facility and the repository program?

Mr. **Conway**. Well, I think I have to answer no, because we are nowhere near where I believe we should be. I think in the report accompanying your bill, when you reported it out, you had testimony which you reproduced in your report from the National Academy of Sciences and a number of other prestigious engineering associations, all of which, in their printed remarks, indicated that from a technical point of view they see very little problem; that they are pretty confident—most confident—that we can safely dispose of nuclear waste with no adverse effect to the health and safety of the public. But, as they properly call attention to, the difficulty is in the public's perception. We have not adequately demonstrated this to the satisfaction of the public, and the public has got to be shown.

So I think the main criticism I would level over the years, and going right back from the very earliest days of the nuclear program, we have not adequately demonstrated to the public that waste can be handled properly.

In fact, I was speaking this morning with Admiral Rickover with regard to yesterday's Washington Post ad and he told me that back in the days when he first went into the nuclear program—when in the days of the Manhattan Engineer District—one of the first things that was brought to his attention while he was at Oak Ridge was a question, "What should we do with some of the waste out of Stag Field up in Chicago?" And they said, "Well, there is no real problem. We know how to handle it. We will handle it." And somebody even suggested buying up on the campus of the University of Chicago.

But he said, "we recognized it as a problem at that time, but we really haven't moved ahead on something that we should have been doing a long time ago." So I think that would be my main criticism.

Mrs. **Bouquard**. I want to commend you for your full-page advertisement. That certainly will bring to the attention of the public that, indeed, we do have legislation to move forward.

Mr. **Conway**. Yes, ma'am.

Mrs. **Bouquard**. Do you support the criteria that the DOE used in separating generic R. & D. from the R. & D. that will be financed by the fund for waste management?

Mr. **Conway**. I guess I look upon the entire program, even in the actual final handling of the problem, that it is all going to be a demonstration program. Really, as we move ahead—I stress the demonstration more than the research—I think the research has been—for all intents and purposes has been done, and it is being demonstrated in other parts of the world. But I would stress the fact that we have to demonstrate it. And I think as we move ahead and constantly move ahead into interim storage and final storage—terminal storage—that each one of those steps is actually a demonstration. It is a demonstration to the public, we know how to handle the problem. So I certainly would support the concept that as we are going ahead with R. & D., and with the stress, as I say, on the demonstration, it is important, a very, very important part of the whole program.

Mrs. Bouquard. Do you think that we need to increase the funding for spent fuel storage techniques? If you do, what additional activities do you think are warranted?

Mr. Conway. Well, I would say the industry has enough confidence, if you will, in this that the industry has come forth with a proposal which, I am glad to say, is being picked up by the administration and, hopefully, by the Congress; that it is prepared to pay the full cost—all reasonable costs—for the storage of the spent fuel and the waste that is generated from the commercial program. In that regard, industry is willing to pay one mill per kilowatt-hour of electricity generated.

That is a fairly significant sum. We figure that's in excess of $6 billion that will be available from the industry to pay for this when we finally get to finally disposing of the waste.

Mrs. Bouquard. Is there any area that you think we could delete from the budget or waste-related activities that you would recommend be terminated? Similarly, are there any that we need to advance—AFR, for instance?

Mr. Conway. I was just going to say there is one field that I feel the current administration hasn't given sufficient attention to, and that's the so-called AFR—away from reactor storage. At one time the industry was interested and eager to assume that responsibility, assume the responsibility of taking fuel from the operating reactors, reprocessing the fuel, and then with the clear understanding that they always had turning over the actual waste to the Government—paying for it of course—but turning it over to the Government for final terminal storage.

Unfortunately, we've seen various administrations come and go and with them, different approaches. So, we have seen a lot of vacillating, and we had an incident where after tremendous sums of money were invested by private industry the former administration came out, and indefinitely deferred reprocessing. In fact, what they said was, "It is going to be illegal to reprocess. We will not permit you to do so." So in one decision—the industry was completely thrown out of the reprocessing field.

Now, the current administration has changed that again and it is inviting industry to come back in. It is very difficult to get risk capital to come back in and take another chance on something like that when in 4 years we may see another change of administration and change of position.

Mrs. Bouquard. The lack of continuity in Federal policy really undermines the private sector?

Mr. Conway. Yes, ma'am.

So the net result is we have utilities today that, depending upon past administrations, had entered into contracts for reprocessing of fuel and expected it would be moving its spent fuel away from the operating reactor site. Now they find themselves in a situation where there is no place where they can send it. They face the difficulty and uncertainties of getting licenses in sufficient time to expand their capability at the site, or to look for other alternatives. They feel, and I think properly so, a need, at least an option, to have some federally operated facility where they can send their spent fuel with the assurance that it will be properly safeguarded, and for which they are willing to pay all reasonable costs. To that extent I would have liked this administration to have taken a stronger support in advocating the AFR.

My understanding is while they are not out actively working toward it, that as long as the utilities are willing to pay for it, the current administration, would not be in opposition to that. So, in getting back to the spirit of your question, I think I would just——

Mrs. BOUQUARD. You would look at this as an add-on to the waste budget?

Mr. CONWAY. Yes, ma'am.

I would like to see some stronger action on their part. Any moneys expended by the Federal Government for an AFR would be paid for by the industry. So there would not be moneys out of the taxpayer's pocket in the final analysis.

Mrs. BOUQUARD. One final question. Do you see any waste-related activities in the DOE budget for 1983 that you would like to see terminated?

Mr. CONWAY. No. As a representative of the nuclear industry I hate to ever tell you any program I think should be eliminated. I think some of my best friends are in all aspects of this. Now, I don't know of any area that I would see that should be terminated.

Mrs. BOUQUARD. Thank you so very much.

Mr. CONWAY. I would like to make one other remark before I end, and that is in the tail end of my statement there are points I have made in support of other projects, and one of which, of course, is the Clinch River. We strongly support the Clinch River project, and the high temperature gas cooled reactor.

Mrs. BOUQUARD. Thank you very much for your fine testimony.

Mr. CONWAY. Thank you.

Mrs. BOUQUARD. Next we have Dr. Jack Kerrebrock.

We welcome you today to our subcommittee, Dr. Kerrebrock.

Dr. Kerrebrock is Associate Administrator for Aeronautics and Space Technology, NASA.

Welcome to our subcommittee today. We have your testimony. You may proceed as you wish, and your entire testimony will be made a part of the record.

STATEMENT OF DR. JACK L. KERREBROCK, ASSOCIATE ADMINISTRATOR, OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. KERREBROCK. Thank you, Mrs. Bouquard.

I am pleased to have this opportunity to appear before you today to discuss cooperative efforts between NASA and the Department of Energy in advanced space nuclear power systems. I have a personal interest of long standing in nuclear power, being an alumnus of ORNL in addition to my present responsibility.

Mrs. BOUQUARD. You certainly have a fine background.

Dr. **Kerrebrock**. Thank you.

Several members of my staff, as well as the representative from the Office of Space Science and Applications, are here to assist me in answering any detailed questions you may have.

NASA has been working closely with DOE and its predecessor organizations in the area of space nuclear power systems for more than 20 years. Our interest stems from requirements for nuclear power systems for a variety of missions for which alternatives such as solar-array battery systems are unsuited. These missions include those which operate in deep space far from the Sun, some which involve long solar occlusion times such as lunar and planetary landers, and others which operate in intense radiation environments such as the Van Allen belts which girdle the Earth at high altitudes. There are two general types of space nuclear power of current interest to NASA, radioisotope thermoelectric generators, or RTGs, and nuclear reactor powered systems. I will discuss each of these in turn along with our relationship to DOE, and finally I would like to respond to your request for comments on NASA's long-term need for DOE support.

The RTG is a device which consists of two basic components, a radioisotope heat source and a thermoelectric generator which converts the heat to electricity. While NASA has considerable capability in the area of thermoelectric conversion, we depend solely on the expertise of DOE in the area of the plutonium-238 radioisotope heat source. RTG's have a long history of use in NASA flight programs. They have been applied in the Nimbus, Apollo, Pioneer and, most recently, in the Voyager program.

The next planned use of RTG's is in connection with the Galileo and the international solar polar missions—the latter is usually called ISPM. These missions depend on the RTG's as their only power source. In order to acquire these units, we entered into a memorandum of agreement with DOE which calls upon DOE to provide the necessary flight units and one common flight spare. NASA is to provide $30 million through fiscal year 1986.

It should be noted that because of the timing in preparation for the fiscal year 1983 budget submittals, neither NASA nor DOE were able to take into account the provisions of the Omnibus Budget Reconciliation Act of 1981 as it may apply to the Galileo or ISPM RTG's. The intent of that law is to shift more of the burden for funding applicable to DOE services to the benefiting user, in this case NASA. The specifics of the present situation and funding requirements for fiscal year 1983 are currently being studied by our respective staffs.

Finally, with regard to the Galileo and ISPM RTG's, it is emphasized that because of our present program commitments and launch constraints, no further slippage in delivery schedule of flight units can be tolerated.

For the relatively low power mission needs encountered to date, which are below 1 kilowatt, the RTG has proven to be an entirely adequate nuclear power source. There are, however, potential civil and military missions which demand very high power levels—100 kilowatts or more. The only practical approach to providing such nuclear power levels is to replace the radioisotope heat source with a nuclear reactor. NASA has long recognized that such a change would be required. Active programs in both reactor and conversion technologies were funded through the 1960's and early 1970's. In the early 1970's, a decision was made to terminate the reactor work. However, development of thermal-to-electric conversion technology compatible with future reactors continued in NASA at a modest level.

In the intervening years, the Soviets achieved an operational capability with space nuclear reactors, which they now employ routinely. Partially spurred by the Russian accomplishments, DOE initiated a small technology effort in fiscal year 1979 aimed at a heat pipe, cooled space reactor. Since that time, the staffs of both NASA and DOE have worked together to assure the compatibility of NASA's systems technology and thermal-to-electric conversion technology and the DOE reactor technology. In fact, during fiscal years 1979, 1980, and 1981, NASA funded work not only at its own laboratories but also at the Los Alamos National Laboratory in the heat pipe area.

NASA decided to proceed more formally with DOE in fiscal year 1982, planning to support reactor technology at a level of $700 thousand provided only that a satisfactory written agreement was arrived at. Such an agreement was drawn up by the respective staffs, signed by NASA and transmitted to DOE for their action in October 1981.

In January of this year, the Department of Defense, through DARPA, indicated its interest in participating in this program, providing only that a satisfactory management approach be agreed upon by the parties involved. This was a significant step in that a second user agency joined NASA in both recognizing need for a national program in this area, and in expressing willingness to support the critical technology efforts necesary for its conduct.

The effort which is being formulated is called the SP-100 program. The first phase has as its objective the establishment of the critical technologies which can enable the subsequent development of a space nuclear reactor power subsystem. Two major milestones are planned for this phase. The first is a preliminary technology review in about 18 months which will measure technology status against specific application needs. The second is the decision to proceed with a ground engineering system. This decision would be made in the 1985-86 time period. The ground engineering system would be completed in the 1989-90 time period, to be followed by a flight application phase in the early 1990's.

Now, the funding requirements for the critical technology phase, which is the first of those that I mentioned, have been estimated to be $6.2 million for fiscal year 1982, $10.4 million for fiscal year 1983, and $15 million for fiscal year 1984 for the combined NASA/DARPA/DOE participation. However, these estimates are certainly subject to the internal and external considerations involved in the normal budgeting process.

NASA believes that, for a progam involving three agencies, strong central authority and accountability are required. To that end, we have proposed establishment of a triagency headquarters level SP-100 Program Office headed by DARPA or NASA as user agencies and supported by deputies from the other users and DOE. The Program Office would direct a single SP-100 Project Office at the NASA Lewis Research Center which would be responsible for all project activities, including conversion and systems work at NASA and reactor work currently performed at DOE. I anticipate that a satisfactory detailed agreement will emerge from the negotiating process presently under way.

Finally, you have requested NASA perceptions on long-range requirements for continued DOE support. While NASA has no approved mission needs for RTG's beyond Galileo and ISPM, it is probable that such needs will exist in the future. While we may be able to maintain and even advance the technology for thermoelectric conversion, it is unreasonable for NASA to acquire the capability required to produce the radioisotope heat source. If DOE or a successor agency is unable to maintain this capability in the future, the Nation's access to a significant range of space mission opportunities will be eliminated. We, therefore, feel very strongly that DOE must maintain the capability to supply heat sources as needed for future programs. In the reactor technology area, the DOE expertise in highly specialized areas of technology such as fuels, materials, heat pipes, and safety are expected to be of significant value to the SP-100 program.

Thank you for the opportunity to discuss these matters with your subcommittee.

[The prepared statement of Dr. Kerrebrock follows:]

HOLD FOR RELEASE UNTIL
PRESENTED BY WITNESS
MARCH 17, 1982

Statement

of

Dr. Jack L. Kerrebrock
Associate Administrator for
Aeronautics and Space Technology

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Energy Research and Production
Committee on Science and Technology
House of Representatives

Madam Chairman and Members of the Subcommittee:

I welcome the opportunity to appear before you today to discuss cooperative efforts between the National Aeronautics and Space Administration (NASA) and the Department of Energy (DOE) in advanced space nuclear power systems. We have worked closely with DOE and its predecessor organizations in this area for more than twenty years. Our interest stems from the fact that nuclear power systems are required for a variety of missions for which alternatives such as solar-array battery systems are unsuited. These missions include many which operate in deep space far from the sun, some which involve long solar occlusion times such as lunar and planetary landers, and others which operate in intense radiation environments such as the Van Allen belts which girdle the Earth at high altitudes. There are two general types of space nuclear power of current interest to NASA, radioisotope thermoelectric generators (RTGs) and nuclear reactor powered systems. I will discuss each of these in turn along with our relationship to DOE, and finally respond to your request for comments on NASA's long-term need for DOE support.

Radioisotope Thermoelectric Generators

The RTG is a device which consists of two basic components, a radioisotope heat source and a thermoelectric generator which converts the heat to electricity. While NASA has considerable capability in the area of thermoelectric conversion we depend solely on the expertise of DOE in the area of the plutonium-238 radioisotope heat source. RTGs have a long history of use in NASA flight programs. They have been applied in the Nimbus, Apollo, Pioneer and most recently in the Voyager program.

The next planned use of RTGs is in connection with the Galileo and International Solar Polar Missions (ISPM). These missions depend on the RTGs as their only power source. In order to acquire these units we entered into a Memorandum of Agreement with DOE which calls upon DOE to provide the necessary flight units and one common flight spare, and for NASA to provide $30.0 million. NASA further agreed to provide this funding on the following schedule: prior years, $5.0 million; fiscal 1982, $5.0 million; fiscal 1983, $6.5 million; fiscal 1984, $4.5 million; fiscal 1985, $6.0 million; and fiscal 1986, $3.0 million.

It should also be noted that because of the timing in preparation of the FY 1983 budget submittals, neither NASA nor DOE were able to take into account the provisions of the 'Omnibus Budget Reconciliation Act of 1981' (PL 97-35 signed 8/13/81) as they may apply to the Galileo/ISPM RTG. The intent of that law is to shift more of the burden for funding applicable DOE services to the benefitting user. The specifics of the present situation and funding requirements for FY 1983 are currently being studied by our respective staffs.

Finally, with regard to the Galileo/ISPM RTGs it is emphasized that because of launch constraints no slippage in delivery schedule of flight units can be tolerated.

Nuclear Reactor Power Systems

For the relatively low power mission needs encountered to date (below one kilowatt) the RTG has proven to be an entirely adequate nuclear power source. There is a large number of potential civil and military missions, however, which demand very high power levels - one hundred kilowatts or more. The only practical approach to providing such nuclear power levels is to replace the radioisotope heat source with a nuclear reactor. NASA has long recognized that such a change would be required. Active programs in both reactor and conversion technologies were funded through the 1960's and early 1970's. In the early 1970's a decision was made to terminate the reactor work. However, research on thermal-to-electric conversion technology compatible with future reactors continued in NASA at a modest level.

In the intervening years, as is now widely known, the Soviets achieved an operational capability with space nuclear reactors, which they now employ routinely. Partially spurred by the Russian accomplishments, in FY 1979 DOE initiated a small technology effort aimed at a heat pipe cooled space reactor. Since that time the staffs of both NASA and DOE have worked together to assure the compatibility of NASA's systems technology and thermal-to-electric conversion technology and the DOE reactor technology. In fact, during FY 1979, 1980 and

1981 NASA funded work not only at its own laboratories but also at the Los Alamos National Laboratory in the heat pipe area.

NASA decided to proceed more formally with DOE in FY 1982, planning to support reactor technology at a level of seven hundred thousand dollars provided only that a satisfactory written agreement was arrived at. Such an agreement was drawn up by the respective staffs, signed by NASA and transmitted to DOE for their action in October 1981.

In January of this year, the Department of Defense, as represented by the Defense Advanced Research Projects Agency (DARPA) indicated their interest in participating in this program, providing only that a satisfactory management approach be agreed upon by the parties involved. This was a significant step in that a second user agency joined NASA in recognizing both need for a national program in this area, and the willingness to support the critical technology efforts necessary for its conduct.

The effort which is being formulated is called the SP-100 program to distinquish it from past activities. The first phase has as its objective the establishment of the critical technologies which can enable the subsequent development of a space nuclear reactor power subsystem. Two major milestones are planned for this phase. The first is a preliminary technology review in about eighteen months which will match technology status against specific application needs. The second is the decision to proceed with a ground engineering system. This decision would be made in the 1985-86 time period. This phase would be followed by a ground engineering phase to be completed in the 1989-90 time period and a flight application phase in the 90's. We realize that this may appear to be a leisurely approach. It is, however, consistent with a prudent use of the available resources.

The total funding requirements are shown through FY 1984 for the critical technology phase in the table below. It should be noted that these are estimates only, subject to the internal and external considerations involved in the normal budgeting process.

	FY 82	FY 83	FY 84
	$M	$M	$M
TOTAL	6.2	10.4	15.0

NASA believes that, for a program involving three agencies, strong central authority and accountability are required. To that end, we have proposed establishment of a tri-agency headquarters level SP-100 Program Office headed by DARPA or NASA as user agency and supported by deputies from the other user and DOE. (DARPA is seen to have probable first use at this time and hence is the recommended choice). The Program Office would direct a single SP-100 Project Office at the NASA Lewis Research Center which would be responsible for all project activities including conversion and systems work at NASA and reactor work currently performed at DOE. I anticipate that a satisfactory detailed agreement will emerge from the negotiating process presently under way.

Need for Long-term DOE or Successor Agency Support

Finally, Madam Chairman, you have requested NASA perceptions on long-range requirements for continued DOE support. While NASA has no approved mission needs for RTGs beyond Galileo and ISPM it is probable that such needs will exist in the future. While we may be able to maintain and even advance the technology for thermoelectric conversion, it is unreasonable for NASA to acquire the capability required to produce the radioisotope heat source. If DOE is unable to maintain this capability in the future, the Nation's access to a significant range of space mission opportunities will be eliminated. We, therefore, feel very strongly that DOE must maintain the capability to supply heat sources as needed for future programs. In the reactor technology area, the DOE expertise in highly specialized areas of technology such as fuels, materials, heat pipes, and safety are expected to be of significant value to the SP-100 program.

Thank you for the opportunity to discuss these matters with your subcommittee.

Mrs. **Bouquard**. Thank you very much, Dr. Kerrebrock.

Our DOE witnesses yesterday told us that at a minimum an additional $5.3 million would be needed in fiscal year 1983 to maintain the flight RTG program for the Galileo and ISPM missions. Does NASA concur that this is the correct shortfall, and if not, what would you project it to be?

Dr. **Kerrebrock**. We concur on the basis that this is the best information that we have, but the information came to us from DOE. Therefore, we have no insight into their needs for this funding. However, the $5.3 million number is the one that we have been given by DOE also.

Mrs. **Bouquard**. So, you concur at the present time that $5.3 million is an accurate assessment of the shortfall?

Dr. **Kerrebrock**. Yes, ma'am, but not on the basis of an independent assessment.

Mrs. **Bouquard**. But to the best of your knowledge at this time?

Dr. **Kerrebrock**. Yes.

Mrs. **Bouquard**. As you know, DOE has proposed reductions in the RTG flight system development and support activities. Since you stated that no slippage could be tolerated what will be the impact on Galileo and ISPM missions, and how will NASA deal with these reductions?

Dr. **Kerrebrock**. Neither of these missions can operate without the RTG's. The Galileo mission is scheduled for launch between May and Au of 1985—ISPM for May of 1986. In order to meet those dates, we have to execute the program as it was planned. If it slips, we have a very serious problem.

Mrs. **Bouquard**. Will the flights be delayed?

Dr. **Kerrebrock**. Those are launch windows, so that it is very difficult to delay beyond, in the case of Galileo, August 1985, unless you delay for a long time. The impact would be very serious, yes.

Mrs. **Bouquard**. That is what I was referring to.

Dr. **Kerrebrock**. We would urge very strongly that funding be found somewhere to continue these programs on schedule.

Mrs. **Bouquard**. Based upon your out-year projections for isotope power system requirements, what do you think is an equitable DOE/NASA funding split to meet these requirements, Dr. Kerrebrock?

This is something we discussed yesterday with DOE.

Dr. **Kerrebrock**. I have a schedule of payments which NASA agreed to reimburse DOE, based on our projection for isotope power systems. We have planned to transfer to DOE money as follows: for 1982, it is $5 million; for 1983, $6.5 million; for 1984, $4.5 million; for 1985, $6 million; and for 1986, $3 million. The total amount of transfer will be $30 million.

Now, this funding is consistent with the ground rules applicable to these mission schedules, et cetera. As I indicated, we have no approved requirements beyond these missions, but we expect that we will have in the out years.

Mrs. **Bouquard**. You say that you will have but there are no planned programs beyond this?

Dr. **Kerrebrock**. No, ma'am, however, we fully expect that there will be new programs approved in the future that will have these requirements.

Mrs. BOUQUARD. You said that the SP-100 mission needed a strong central authority to require accountability. Since you have been working with DOE, or its counterpart, for about 20 years, have you seen any problems in this area?

Dr. KERREBROCK. The problem is not with DOE as such, but rather that we have the strong conviction that the user agency should have the central management authority for a program like this in order to be sure that mission requirements are met in a timely way.

Mrs. BOUQUARD. Is there anything different about the SP-100 project that makes the project management issue so crucial at this time?

Dr. KERREBROCK. Only that it involves three agencies. There have been other programs in the past that NASA has been involved in that had a strong centralized management like this, such as the nuclear rocket program.

Mrs. BOUQUARD. Since NASA and DARPA and DOE presently are engaged in negotiations to produce a management plan for the SP-100 development, what do you think represents an appropriate role for each of the agencies? What do you feel represents an equitable arrangement for a management plan?

Dr. KERREBROCK. It seems advisable that the DOE role should be to produce the nuclear reactor component under the supervision, or coordination perhaps, of a central management office, the program office. NASA should produce the energy conversion technology and carry on the system integration. DARPA is a potential user of the space nuclear reactor so it should have a role in the system definition. DARPA is an alternate to NASA for the head program office role. The DARPA probably will have the first requirement for this system, though that is not exactly clear yet.

Mrs. BOUQUARD. What do you think is an equitable out-year funding split among the three agencies in the SP-100 program.

Dr. KERREBROCK. What we have been recommending and attempting to negotiate are the following numbers. I can read them to you or I can give them to you for the record, whichever you prefer. Would you like me to give them to you now?

Mrs. BOUQUARD. Sure, please proceed.

Dr. KERREBROCK. In fiscal year 1982, NASA is planning to put in $2.9 million, DOE $1.3 million, and DARPA $2 million. In fiscal year 1983, in the same order, they are $3.9 million from NASA, $2.5 million from DOE, and $4 million from DARPA.

Mrs. BOUQUARD. In fiscal year 1984?

Dr. KERREBROCK. Yes; $4 million from DARPA. In fiscal year 1984, $5 million, $4.8 million, and $5.2 million; and in fiscal year 1985, $5 million, $4.8 million, and $5.2 million. So, that after the startup transient it is pretty nearly a third.

Mrs. BOUQUARD. Thank you very much, Dr. Kerrebrock.

Mr. Volkmer.

Mr. VOLKMER. I have no questions.

Mrs. BOUQUARD. Mr. Lowery.

Mr. LOWERY. Thank you, Madam Chairman.

Doctor, on page 2 of your testimony you mention the $30 million that DOE currently carries. Of course, in the Omnibus Budget Reconciliation Act of 1981, the intent of the law was to shift the burden for funding from DOE to the user with the ultimate benefit. What progress is being made in that regard, and how will it come about, in what years, the funding sources, and the like?

Dr. **Kerrebrock**. During the fiscal year 1983 budget process, there was no opportunity to renegotiate this in response to that direction, so that it has had no significant impact so far except that——

Mr. **Lowery**. What do you mean there is no opportunity?

Dr. **Kerrebrock**. Let's say that the opportunity for coordination on that issue did not appear during the 1983 budget process, and the numbers that you see have not been adjusted by that direction.

Mr. **Lowery**. OK.

I don't know what your window is for putting these things together. I know we are in the process of wrestling with the budget now, and it won't be effective for some months. Can you explain a little bit more in terms of not having an opportunity to get together?

Dr. **Kerrebrock**. My response was directed at our opportunities for that kind of redirection during the preparation of the 1983 budget. We did not have an opportunity to make those corrections at that time.

Mr. **Lowery**. So the earliest we will see it is really about fiscal year 1984?

Dr. **Kerrebrock**. If that is the direction of the Congress, then we will attempt to carry that out. Now, I must say that we have not put those planning numbers in the NASA budget at the present time.

Mr. **Lowery**. How much of the 1983 budget would NASA pick up?

Dr. **Kerrebrock**. It is $6.5 million for the Galileo and ISPM RTG's at the present time.

Mr. **Lowery**. OK.

Thank you.

Thank you, Madam Chairman.

Mrs. **Bouquard**. Thank you very much, Mr. Lowery.

Thank you, Dr. Kerrebrock.

Next we welcome our panel of witnesses, our high-temperature gas reactor panel. We have Dr. Harold Agnew. Dr. Agnew is president of General Atomic Co. Mr. Walker is chairman of Gas-Cooled Reactor Associates. Finally, we have Mr. Robert Richards, general manager of Advanced Reactor Systems Department of General Electric Co. I might say that these gentlemen are certainly dear friends to this subcommittee and we certainly welcome you here today to be with us.

We have your testimony, and you may proceed as you wish. But your entire testimony will be made a part of the record.

Please proceed, Mr. Walker.

STATEMENT OF RICHARD F. WALKER, PRESIDENT, PUBLIC SERVICE CO. OF COLORADO AND CHAIRMAN OF GAS-COOLED REACTOR ASSOCIATES

Mr. **Walker**. Thank you, Madam Chairman.

It is our pleasure to be here again.

For the record, I am Richard F. Walker. I am chairman of the Gas-Cooled Reactor Associates, which is a group of utilities supporting the high-temperature gas-cooled concept. I am also president and chief executive of the Public Service Co. of Colorado and the owner of the Fort St. Vrain nuclear generating plant which is the only operating gas-cooled reactor in the United States.

I would like to just briefly bring the committee up to date on the progress we have made with our operating reactor. During 1981 we did achieve 100 percent power with our Fort St. Vrain plant with an efficiency of 38.5 percent, which is the highest thermal efficiency of any nuclear plant in the United States. We continued to have low radiation exposure for the people that work in the plant, approximately 2 percent of the exposure you would expect in a normal nuclear plant.

We have continued to put our own company funds into the plant to improve the systems. In 1981 we spent some $12 million upgrading systems, and we are in the process of spending $22 million in 1982 to make this a more reliable and more efficient plant for our own use. We have been down to make some of these changes and we expect to bring the plant back into operation shortly so that it will be available for this summer, and we are looking forward to its continued operation, having set new records on annual output and peak demand last year.

We are here today to discuss the 1983 fiscal budget, and particularly the lead project which we have been working on consistent with the committee's direction last year. Our focus is on a standardized 2,240-megawatt thermal steam cycle cogeneration system for electricity and process heat steam application. We have identified some lead project candidates, potential candidates and have identified those in the letter to Chairman Fuqua and to you, Madam Chairman, and have also submitted a lead project strategy plan along with that letter.

Briefly, those five utility potential user groups are, first, an intermountain group consisting of my company, the Idaho Power Co., and the Colorado-Ute Electric Association for a potential plant at the Idaho reactor test station which would be of use to those utilities in the West for electric generation, and would also have the potential for some steam supply at that area and could be a backup for the production reactor strategy.

Another group is the Gulf States Utilities and Gulf Oil Refining to use a HGTR to provide steam and electricity for a large refinery in the gulf area.

Another group was the Florida Power & Light group who have a site in south Dade County, which we have discussed with you before.

A Mid-Atlantic utility group made up of Public Service Electric & Gas, Philadelphia Electric, and Delmarva for a potential steam cycle and possibly cogeneration in the New England area, the middle—that area.

And another one in the Southwest is the Arizona Public Service Co.

We have secured the interest of these utility groups in this and are working toward the finalization of the design for the lead project consistent with these budget provisions.

The utility/user industry would support the commercial value of the plant and the project and engineering costs that go with first-of-a-kind equipment, and the vendor/supplier would provide supporting facilities and prices on components, and fuel, and the Government support would be required for front-end design, technology developments, and fuel cycle work and some project financing for first-of-a-kind equipment costs. Our estimates show of the total cost of the lead project, 75 percent would be borne by the private sector and about 25 percent for the Government sector.

This compares with the money spent to date, of which about 70 percent has been spent by the private industry to date. DOE would be asked to advance the lead project design and the NRC program would be supportive of the lead plant strategy.

Specifically, we are asking that for fiscal 1983, funds be restored to complete the conceptual design and advance the technology to support a 1995 startup date for the lead plant. This will require a minimum of $40 million. For advance systems such as the modular reactor system that Dr. Richards will discuss later, we are recommending $5 million, and for the continuation of the thorium fuel cycle development, $3 million.

We urge subcommittee support for this full amount, and we also urge you to transmit a message to the administration as you have done in the past so that we can keep this important activity progressing.

That summarizes my testimony, and it is our pleasure to be here.

[The prepared statement of Mr. Walker follows:]

STATEMENT SUBMITTED FOR THE RECORD

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

FY 1983 DOE AUTHORIZATION
HIGH-TEMPERATURE GAS-COOLED REACTOR PROGRAM

RICHARD F. WALKER
PRESIDENT OF PUBLIC SERVICE COMPANY OF COLORADO
AND
CHAIRMAN OF GAS-COOLED REACTOR ASSOCIATES

MARCH 17, 1982

STATEMENT SUBMITTED FOR THE RECORD
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
FY 1983 DOE AUTHORIZATION
HIGH-TEMPERATURE GAS-COOLED REACTOR PROGRAM
RICHARD F. WALKER
PRESIDENT OF PUBLIC SERVICE COMPANY OF COLORADO
AND
CHAIRMAN OF GAS-COOLED REACTOR ASSOCIATES

Madam Chairman and Members of the Subcommittee, my name is Richard F. Walker, and I am President of Public Service Company of Colorado and Chairman of Gas-Cooled Reactor Associates (GCRA). I appreciate the opportunity to appear before you today to represent Utility/User support for the High-Temperature Gas-Cooled Reactor (HTGR) Program.

Historically, the Utility/User industry has a long record of support for the HTGR and has contributed over $200 million toward the present state of HTGR development. In particular, this support has been instrumental in the design and construction of two HTGR facilities: the Peach Bottom developmental plant that was operated by the Philadelphia Electric Company and the Fort St. Vrain demonstration plant which is currently operating and providing electricity for the Public Service Company of Colorado.

For the past four years, the Utility/User industry, through Gas-Cooled Reactor Associates, has been working with all involved parties within the Government, a broad sector of the nuclear vendor/supplier industry, National laboratories, and foreign HTGR Program participants to establish the HTGR as a viable, commercial energy alternative. In addition to its demonstrated application for highly efficient electricity generation, the HTGR, because of its high-temperature capability, is ideally suited to cogeneration applications with various industrial processes that are presently dependent on fossil energy sources. For all these applications, the evaluated energy cost estimates associated with the HTGR indicate the potential for significant economic savings. Other important attributes are associated with the inherent safety and low environmental impact characteristics of the HTGR. These characteristics result in less reliance on engineered safety systems, added margins for meeting certain licensing criteria, greater siting flexibility, and reduced radiation exposure to plant personnel. Further, given the multibillion dollar investment of central power plants today, the HTGR's inherent safety provides important plant investment protection to both shareholders and rate payers. In our view, therefore, the bases for National support for securing the HTGR as a commercial alternative are compelling.

As you are well aware, financial and regulatory difficulties and reduced growth in many parts of the country have resulted in the deferral or cancellation of numerous generation facilities during recent years. The industry's inability to build new capacity in the near-term implies a strong future demand for replacement and new power plants when the financial and regulatory environments are more receptive. In the interim, it is essential that the Nation maintain the foresight for continuing the development of promising energy alternatives such as the HTGR.

To this end, we feel that the Utility/User industry continues to make significant progress. Through GCRA, the Utilities/Users actively continue to develop a Lead Project, guide the associated technical programs and provide overall Program integration support to DOE. Financial support through GCRA for 1981 and 1982 is about $2.5 million per year, including support from EPRI. In addition, the Public Service Company of Colorado which owns and operates the Fort St. Vrain HTGR demonstration plant, has spent approximately $12 million in 1981 and has budgeted about $22 million for 1982 for plant improvements that support the continued invaluable demonstration role of this plant.

This year, I am proud to report that the Fort St. Vrain plant achieved 100% power for the first time in early November, 1981. Full-power operation was maintained for about 60 hours to accumulate data before the plant was shut down for a planned maintenance outage. All the plant's systems and components performed at or near design conditions during the full-power test run. Of particular importance, no core temperature fluctuations were observed during the rise to 100% power or during full power operation. In the past, fluctuations, caused by thermal hydraulic redistribution of the flow of helium coolant in the reactor core, have been the basis for the NRC restricting the plant's operation at the 70% power level. However, the recently installed core region constraint devices have resolved this problem. The Fort St. Vrain facility, while operating at 100% of rated reactor thermal power, generated 325 megawatts of electricity and operated at more than 38.5% net efficiency, the highest of any nuclear plant in the U.S.

With regard to fuel integrity and radiation exposure to plant personnel, Fort St. Vrain has had an exceptional operating record. Operating data indicate that the amount of radioactivity carried in the helium coolant has been less than 2 percent of the design limit, demonstrating the structural integrity of the coated fuel particles and the graphite core structure. A comparison of 1980 personnel exposure data for Fort St. Vrain and light water reactor plants in the U.S. indicates that Fort St. Vrain had an average annual person-rem exposure rate per GW(e)-year of less than 2 percent of the average exposure rate in light water reactor plants. This low personnel exposure level is even more significant in view of the fact that Fort St. Vrain has virtually unlimited access into the reactor building for all operations and maintenance personnel.

Fort St. Vrain is expected to begin operation this month after a successful maintenance outage and we are hopeful that the NRC will grant approval for continued operation at 100% power. To date, the plant has delivered approximately 3 billion kilowatt-hours of net electrical energy. We are confident that Fort St. Vrain will continue to provide kilowatt-hours and critical confirmation and demonstration of many HTGR concepts. The Public Service Company is pleased to be playing a key role in this effort.

During the past year, both Congress and the HTGR Program participants have recognized that the key to securing the HTGR as a commercial alternative is the establishment of a well conceived Lead Project. This aspect is reflected in last year's Congressional budget guidance language that was initiated by the House Science and Technology Committee. To this end, GCRA and the other Program participants are aggressively addressing and responding to the provisions outlined by Congress. This effort will culminate in June 1982 with a "Lead Project Decision Package" that will provide a sound basis and structure for advancing the Lead Project commitment. The Package is based on the four loop, 2240 MW(t) HTGR Steam Cycle/Cogeneration (SC/C) plant design that has been established as the principal focus of the HTGR Program for the following reasons: (1) the technical feasibility of the system is assured through long-standing design experience and the Fort St. Vrain demonstration plant; (2) relative to the other Project options, the HTGR-SC/C system requires the least resources, involves the least technical risks, and can be deployed on the earliest schedule. Accordingly, this option warrants the greatest private sector financial support; (3) the deployment of the HTGR-SC/C system provides a large fraction of the technology and industrial infrastructure required for the more advanced, follow-on HTGR systems; and (4) the HTGR-SC/C system serves the large electric generation market and is ideally suited for cogeneration with central, baseloaded industrial applications requiring process steam and electricity. Further, with the modular loop concept, the two-loop or six-loop designs may also be applied to meet broad Utility/User power rating needs in the follow-on commercial market.

The Lead Project Decision Package is structured into a series of issue-oriented documents that address the associated technical, financial, and institutional issues that confront all the parties contemplating involvement in such a Lead Project. For example, the Baseline Design and Cost Report defines the plant design and costs, operating characteristics, and construction schedule. Detailed planning documents in the form of a Design and Technology Development Plan and a Licensing Plan define the technical and licensing activities and associated costs necessary to support the deployment of the Lead Project. Further, these planning documents will constitute the basis for managing and controlling such activities. The Lead Project Strategy Plan addresses institutional issues such as Project organization and management, vendor/supplier development, cost/risk sharing between the private and public sectors, and Project financing.

The development of the Lead Project Decision Package is in concert with the development of multiple Lead Project candidates with specific Utilities/Users. Currently, there are five regional Projects that have been identified as potential candidates for a Lead Project as well as follow-on Projects. For example, Public Service Company of Colorado, Idaho Power Company, and Colorado-Ute Electric Association have an interest in the HTGR-SC/C system to meet new generation requirements. Project evaluation studies during 1981 have established that a Lead Project would be located at or near the Idaho National Engineering Laboratory (INEL) in order to centralize the generation capacity for sharing throughout the Intermountain Region and to utilize the associated resources at INEL. In particular, EG&G could serve as Project manager and plant operator. Such a Lead Project has the growth potential for a nuclear energy park with associated fuel cycle facilities and cogeneration applications. In addition, such a Lead Project, with appropriate ownership arrangements and fuel cycle modifications, could serve as a supplement or backup to our Nation's military production reactors. Further growth potential for the HTGR in the Intermountain Region is related to cogeneration applications with the emerging synfuel industries with oil shale, tar sands, and coal.

The other regional Lead Project candidates and the respective, principal Utilities/Users are:

- Gulf Coast Region - Gulf States Utilities and Gulf Oil Refining and Marketing Company.

- Mid-Atlantic Region - Public Service Electric and Gas, Delmarva Power & Light and Philadelphia Electric.

- Southeast Region - Florida Power and Light.

- Southwest Region - Arizona Public Service.

In each case, the respective Utilities/Users have an interest in and need for the HTGR-SC/C system that would be deployed in the mid to late 1990's and hence warrant commitments within the next few years.

In response to the Congressional requirements for continued support to the HTGR Program in FY 1983, I have submitted a letter to you and Chairman Fuqua on behalf of all the identified Lead Utility/User candidates to acknowledge our continued and genuine intent to aggressively pursue and support a HTGR-SC/C Lead Project. Accompanying this letter is a copy of the Lead Project Strategy Plan that serves as a framework for planning and negotiations between the prospective Lead Project participants towards the early realization of such a Lead Project.

However, as you are aware, there are pervading issues of economic and regulatory instability that presently confront the utility and nuclear industries. Further, there are design, technology and institutional development requirements for the HTGR-SC/C system that must be met before any party can commit to a Lead Project. The resolution of these requirements has begun and will be advanced through the Lead Project Decision Package.

Regarding the cost-sharing arrangements for the Lead Project, it has been GCRA's consistent intent that a private sector Lead Project entity will support the construction of the Lead Plant to the extent of its commercial value. In addition, the Utility/User industry, through GCRA and EPRI, will support a share of front-end costs associated with the Lead Project. Vendor/supplier support for the Lead Project is expected through an industrial team that will provide the design and manufacturing capabilities required for the Project. The vendor/supplier team would share in the Lead Project risks through firm prices on the plant components and fuel supply, and provide a broadened vendor/supplier infrastructure for subsequent HTGR commercial plants. Government financial support is required for the front-end design and technology development of nuclear systems and components, fuel cycle development and demonstration, and Project financing support to offset first-of-a-kind costs and risks associated with the Lead Project.

Because of the advanced technical nature of the HTGR system and the large capital costs associated with the design and construction of a Lead Project, conventional financing schemes are not sufficient to ensure the successful construction and operation of the Lead Project. The costs and risks associated with establishing the HTGR as a commercial option are substantial and require new, innovative financing techniques which must include government participation. Potential financing schemes must integrate government support and incentives into a unique Lead Project financing framework to take advantage of the maximum degree of private sector participation. As developed in the Lead Project Strategy Plan, our intent is to finance the Lead Project through a cooperative private/public sector effort with industry paying the major fraction, approximately 75%, of the total Lead Project costs.

Regarding government support for FY 1983, GCRA urges the House Subcommittee on Energy Research and Production to provide the DOE budget authority for advancing the HTGR-SC/C design and technical programs to support industry's Lead Project development activities. In particular, work in FY 1983 is required to: (a) complete the HTGR-SC/C conceptual design that will resolve the remaining design issues and complete major trade-off studies; (b) establish detailed cost estimates and schedules for the Lead Plant; and (c) continue critical-path technology programs to support the conceptual design and a Lead Plant startup date of 1995. These activities require a minimum budget level of $40 million which includes $2 million for R&D equipment. It is also important to continue support of promising advanced HTGR systems, such as completing the pre-conceptual designs and cost estimates of the modular HTGR systems. We are recommending $5 million for this effort in FY 1983. Finally, support should continue for the HTGR thorium fuel cycle development. Recommended work in this area consists of spent fuel management for the once-through, low enriched uranium fuel; development of the high enriched uranium (HEU) fuel cycle; and continued fuel reprocessing development for spent HEU fuel with emphasis on continuing the cooperative technical programs with the Federal Republic of Germany. These activities will require $3 million in FY 1983.

Madam Chairman, we acknowledge that these budget recommendations must be considered again in the absence of the Administration's budget support for the HTGR Program. However, we feel that our basis for support is stronger than ever. In addition to the Utility/User progress enumerated before and the Utility/User support for a Lead Project as outlined in my letter, there has been real progress with all elements of the Program. The vendor/supplier involvement has broadened and strengthened, as reflected by the testimony being submitted by General Atomic, General Electric and Combustion Engineering. Support by DOE in structuring the Program to be responsive to the Lead Project technical requirements has been most important. Further, DOE continues to encourage the private sector initiative for the Lead Project as reflected by the language in their FY 1983 budget submittal. In addition, NRC activities are directly responsive to the Lead Project's safety and licensing requirements as reflected in their draft issue of a HTGR Safety Research Program Plan. With continued, strong Congressional support for FY 1983, we will continue to make real progress toward the realization of the HTGR technology. Thank you for the opportunity to present the Utility/User viewpoint to your Subcommittee.

Mrs. BOUQUARD. I would like to call on Dr. Agnew, now, the president of General Atomic, for his comments. Dr. Agnew.

STATEMENT OF DR. HAROLD M. AGNEW, PRESIDENT, GENERAL ATOMIC CO.

Dr. AGNEW. Madam Chairman, I would like to accept your offer to submit for the record my prepared statement. I am Harold M. Agnew, president of General Atomic Co. I would like to ask your permission to submit for the record this particular document entitled "High Temperature Gas-Cooled Reactor Program" which we have made available, which will supplement those materials in my prepared statement.

Mr. VOLKMER. That will be made a part of the record along with your statement.

Dr. AGNEW. Thank you very much.

Again, I will just hit a few of the high points and not repeat those points which Mr. Walker covered.

The requested level for funding in 1983 will provide for completion of the lead plant conceptual design, schedule, and cost estimates; completion of the preliminary site review, licensing document, and environmental impact statement, completion of the management plan; and continuation of particular studies which are required because of site specifics.

The base technology activities in 1983 would include the initiation of the full-scale core auxiliary heat exchanger tests; the start of the main circulator bearing and seal test; and the confirmation of the graphite materials data and the selection of core support graphite criteria.

In the spent fuel treatment program, which was funded this year at $3 million, we would urge that this be continued at that particular level, which will allow the ongoing HGTR fuel cycle activities under the leadership of the Oak Ridge National Laboratory to proceed, and these activities also include continued operation of the HGTR pilot recycle plant in San Diego.

The Oak Ridge National Laboratory, which has been a participant in the HGTR technology development for over 20 years, has also proceeded in 1982 with a major gas reactor test component which is called a core flow test facility.

With those brief comments I would again like to express the appreciation of this community who believes that with 90 percent of the total energy reserves in the United States, which we own in the form of uranium and thorium, that this technology should be pursued, and as Mr. Walker mentioned, it is the only nuclear technology which allows us in the end to replace fossil fuels.

Thank you very much, Mr. Chairman.

[The prepared statement of Mr. Agnew, plus document mentioned above, follows:]

STATEMENT SUBMITTED FOR THE RECORD

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY

FY 1983 DEPARTMENT OF ENERGY AUTHORIZATION
HIGH TEMPERATURE GAS-COOLED REACTOR PROGRAM

HAROLD M. AGNEW
PRESIDENT
GENERAL ATOMIC COMPANY

MARCH 17, 1982

Madam Chairman and Members of the Subcommittee, I am Harold M. Agnew, President of General Atomic Company. I appreciate the opportunity to represent the views of my company in support of continued development of the High Temperature Gas-Cooled Reactor.

The High Temperature Gas-Cooled Reactor (HTGR) is an advanced, high efficiency converter reactor system which, in addition to serving the historic role of nuclear power in electrical generation, offers a unique capability to provide high temperature steam and heat to meet the significant needs of the industrial process industries in a cogeneration mode of operation. In addition, the HTGR offers the benefits of the highest safety margins of a nuclear system, along with reduced exposures of operating personnel, lower levels of gaseous, liquid, and solid waste discharge, reduced cooling water requirements, and improved siting flexibility. The HTGR can also serve the defense needs of our nation as a Replacement Production Reactor.

The basic technology of the HTGR has been demonstrated by the operation of the 40 MW(e) Peach Bottom I nuclear plant during the years 1967 through 1974. The 330 MW(e) Fort St. Vrain nuclear station, which successfully reached 100% of design power in 1981, is currently demonstrating key engineering technologies specific to the HTGR. The next stage of development which would establish the basis for commercial deployment of the HTGR is a Lead Plant Project, the prime objective of which is to demonstrate a full scale commercial technology.

The current National HTGR program is focused on the development of the technical, financial and institutional information and commitments required in advance of a decision by the involved parties to proceed with an HTGR Lead Plant. Gas-Cooled Reactor Associates, in their statement before this Committee, will review the overall program activities with particular emphasis on the financial and institutional areas involved in the preparation of a Lead Project Decision Package. They will also identify activities ongoing with specific Lead Project candidates. I will therefore concentrate my testimony on the technical, programmatic, and applications activities.

The technical program activities have placed primary emphasis on advancing the design and supporting technology for the 2240 MW(t) HTGR steam electric/cogeneration plant which serves as a basis for the Lead Project Decision Package. The program is also assessing the capabilities and economics of the HTGR to provide process steam and process heat for industrial applications, particularly the near term applications where the HTGR can generate high temperature (1000°F) steam to substitute directly for fossil energy.

The application of nuclear energy to industrial processes represents a major opportunity to improve the future energy balance and energy economics in the United States. In 1980 over 26% of the U.S. gross energy consumption was in the industrial sector with over 4/5 of that being provided by either natural gas or oil. Detailed studies have shown that 77% of the total industrial heat requirements are at temperatures of 1000°F or less and that about 1/2 are currently delivered to the process in the form of steam. The HTGR has the unique capability to serve most of this market.

Application studies have shown that HTGR steam electric/cogeneration systems integrate easily with major processes including those in the chemical, petroleum, shale oil, tar sands and metal refinery industries, and that the economics are favorable when compared with the other long term alternative - coal. Further, the use of nuclear energy rather than coal will result in reductions in emissions such as SO_x, NO_x, and CO_2, and particulates by from 40 to 100%.

Potential longer term applications involve HTGR reactors with higher operating temperatures. These reactors can serve higher temperature process heat markets such as methane reforming, direct coal gasification, and eventually direct water splitting for hydrogen production. At the higher operating temperatures, the HTGR may also be used to generate electricity using closed cycle helium gas turbines with overall efficiencies of up to 50%.

High Temperature Gas-Cooled reactors, when used for electricity production, offer higher thermal efficiencies (approximately 39%) than the existing LWR technology as well as improved fuel utilization by employing the uranium/thorium fuel cycle. For process steam applications of the HTGR involving the series cogeneration of electricity, overall energy utilization efficiencies of above 90% can be achieved. The HTGR also has inherent safety characteristics; inert helium gas as a single-phase coolant, prestressed concrete reactor vessel, and a massive high-heat capacity graphite core, which combine to significantly reduce both the likelihood of accidents and the potential consequences to the public and facility itself.

The broad potential applications and anticipated benefits from the HTGR has resulted in a major segment of the electric utility industry (acting through Gas-Cooled Reactor Associates) and major oil, gas, process steam users and chemical firms, supporting the development of gas reactors. Through FY'81 private industry has invested over $1 billion to develop this technology. It is the only nuclear program which has received the majority of its development funding from the private sector.

The benefits which can be realized from the HTGR for either electric production or process steam and heat applications has been recognized in West Germany and Japan. Both countries have well established HTGR development programs with 1981 national budgets of $200M and $35M, respectively. A formal agreement exists between the U.S. and the governments of Germany, Switzerland, and France permitting a cooperative program for the development of the HTGR. A number of industry-to-industry agreements are also in place involving the exchange of both technology and personnel. The Japanese have indicated the desire to develop close relationships with the U.S. program and steps have already been taken at the industry level. The common objectives of the West German and Japanese programs and their desire for cooperation provide an opportunity for joint development activities which would benefit all parties.

The impediments to the commercial deployment of the HTGR are rooted in the institutional problems besetting all of the nuclear industry and the need for confirmation of its technical and economic benefits through a Lead Plant Project. The major objectives of the Lead Plant Project include:

(1) Demonstration of full commercial scale HTGR systems and components including features incorporating technology evolution and Fort St. Vrain operational experience.
(2) Establishing the licensing criteria for HTGR systems.
(3) Confirming the incentives of the HTGR nuclear system for electric production and cogeneration.
(4) Establishing a broad industrial infrastructure to support a subsequent commercial HTGR industry.

The Lead Plant Project approach is based on a phased program, with defined milestones. The progress of the program through the several phases preceding the commitment to construction of the plant would require the agreement at each phase by all the participants on the incentives to proceed and on the management, cost and risk-sharing in the next phase.

The Project Definition Phase (FY'81 through FY'83) is focused on the preparation of a decision package for proceeding to Title 1 design. This decision package will provide the plant conceptual design, schedule and cost estimates, Environmental Impact Statement (EIS) and project management plan. During this phase, the lead plant operator/owner and site will be identified. The Preliminary Design Phase (FY'84 and '85) will be devoted to the development of the Title 1 design and the associated licensing effort. The Detailed Design Phase (FY'86 and '87) will provide the final design and issuance of a Construction Permit (CP). Firm priced bids will be available on all major plant components. The successively more detailed cost estimates and schedules, as well as the management and cost sharing plan, will provide the basis for proceeding to the Lead Plant Construction Phase.

The primary responsibility of the government on the program will be to support the development of appropriate technology and first-of-a-kind design, and to establish a framework for government support or incentives which encourage private sector participation. The intent of the financial plan is for the commercial value of the Lead Plant and other program costs, which represent approximately 75% of the total Lead Project costs, to be provided by the private sector.

Substantial progress was made on the Project Definition Phase during FY'81. The reference design was established, significant work on the nuclear system conceptual design was completed, preliminary site-specific studies for candidate utilities were completed, and application studies on oil shale, heavy oil, chemical and refining and synthetic fuel production were prepared.

Base technology development included completion of priorized design data need packages, selection of reference fuel for LEU-Th fuel cycle, initiation of construction of developmental coater for LEU fuel particles and recommendations for enhanced safety features.

The current FY'82 HTGR steam electric/cogeneration Lead Project activities will result in 60% completion of the nuclear steam conceptual design, completion of preliminary site specific studies for two candidate projects (Gulf Coast refinery/chemical complex, a Southeastern aluminum processing and reduction project) and completion of project decision packages and the preliminary management plan.

FY'82 HTGR base technology development will initiate non-destructive examination of test fuel elements irradiated in the Fort St. Vrain reactor, prepare the test facility for main circulator bearings and seals tests, and initiate air flow tests of upper and lower core plenums.

For FY 1983, GA requests that the House Subcommittee on Energy Research and Production provide budget authority of $48 million (including $2 million for capital R&D equipment) for the HTGR program, broken down as follows:

For HTGR Project and Base Technology	$45M
- Lead Plant Design and Application Studies	$16M
- Base Technology Development	$24M
- Advanced Systems	$ 5M
For Spent Fuel Treatment Program	$ 3M

The requested level of funding in FY'83 will provide for completion of HTGR Lead Plant conceptual design, schedule and cost estaimtes; completion of the preliminary site review, licensing document and EIS, completion of the management plan; and continuation of site specific studies.

Base technology activities in FY'83 would include the initiation of full-scale core auxiliary heat exchanger tests; the start of main circulator bearing and seal tests; and the confirmation of graphite materials data and the selection of core support structure graphite.

Among the proposed advanced systems activities for FY'83 is the completion of the pre-conceptual design and feasibility assessment of small (approx. 250 MWt) HTGR systems for process steam applications. The spent fuel treatment program would permit completion of the fluidized bed burner off-gas treatment test program and for continuation of Lead Plant spent fuel transportation, storage and processing studies.

The Spent Fuel Treatment Program, funded at $3M in FY'82, with an additional $3M recommendation in FY'83, will allow the ongoing HTGR fuel recycle activities under the leadership of the Oak Ridge National Laboratory to proceed. These activities include the continued operation of the HTGR pilot recycle plant at General Atomic Company.

Oak Ridge National Laboratory, a participant in HTGR technology development for over 20 years, has also proceeded in FY'82 with a major gas reactor test component, the Core Flow Test Facility.

Madam Chairman, I would ask your permission to submit for the record, along with this statement, a copy of a document entitled "High Temperature Gas-Cooled Reactor Program" which will supplement the information provided in this statement.

Finally, Madam Chairman, I would like to express our appreciation for the continuing support of this subcommittee for the HTGR program which has made it possible to achieve the technical progress and increased Utility/User support reported on today. I trust that after reviewing this program and the testimony of other program participants, you will be able to support the request for FY'83 funding of the HTGR program.

Thank you for the opportunity of appearing before your subcommittee today.

* * * * *

HIGH TEMPERATURE GAS-COOLED REACTOR PROGRAM (HTGR)

BRIEFING DOCUMENT
ON

HIGH TEMPERATURE GAS-COOLED REACTOR PROGRAM
(HTGR)

PREPARED BY
GENERAL ATOMIC COMPANY

PREFACE

THIS DOCUMENT HAS BEEN PREPARED BY GENERAL ATOMIC TO PROVIDE BACKGROUND MATERIAL ON THE HIGH TEMPERATURE GAS-COOLED REACTOR (HTGR) PROGRAM USEFUL TO DELIBERATIONS ON THE FY-83 NUCLEAR BUDGET. THE HTGR PROGRAM HAS MAINTAINED STRONG USER SUPPORT DURING A PERIOD OF NUCLEAR MALAISE BECAUSE IT CAN UNIQUELY FULFILL A MAJOR ROLE IN THE NATIONAL ENERGY PICTURE, BOTH AS A SECOND GENERATION, SAFER APPROACH TO NUCLEAR ELECTRIC GENERATION AND TO SUPPLEMENT OR DISPLACE FOSSIL FUELS IN PROVIDING HIGH TEMPERATURE ENERGY TO THE PROCESS INDUSTRIES.

THE FY-81 AND FY-82 DOE/INDUSTRY PROGRAM HAS MADE SIGNIFICANT PROGRESS IN ESTABLISHING THE FOUNDATION FOR PROCEEDING WITH AN HTGR COGENERATION LEAD PLANT PROJECT AND IN ESTABLISHING THE TECHNOLOGICAL COMPATIBILITY, ENVIRONMENTAL AND ECONOMIC BENEFITS FOR A NUMBER OF SPECIFIC COGENERATION APPLICATIONS. ALSO DURING THIS PERIOD, THE HTGR HAS BEEN ESTABLISHED AS THE LEADING CANDIDATE TO MEET THE DEFENSE PROGRAM NEED FOR A REPLACEMENT PRODUCTION REACTOR.

THE PROGRAM PARTICIPANTS (INCLUDING THE UTILITY, PROCESS AND SUPPLIER INDUSTRIES) STRONGLY URGE A CONTINUATION OF U.S. GOVERNMENT SUPPORT FOR THE HTGR PROGRAM TO INSURE THE AVAILABILITY OF THIS UNIQUE OPTION AT SUCH TIME AS THE INSTITUTIONAL BARRIERS TO NUCLEAR ENERGY HAVE BEEN OVERCOME.

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HTGR BENEFITS

MULTIPURPOSE ENERGY ROLES

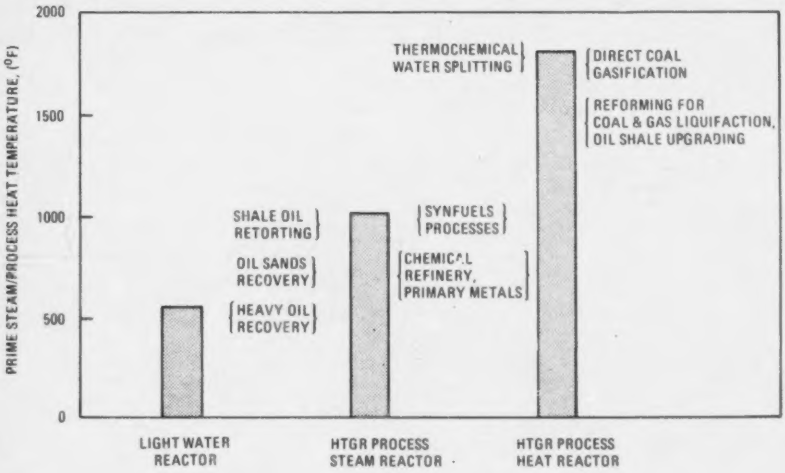
HIGHER PERFORMANCE ELECTRICITY PRODUCTION

- HIGHER THERMAL EFFICIENCY (UP TO 40%)
- REQUIRES LESS URANIUM

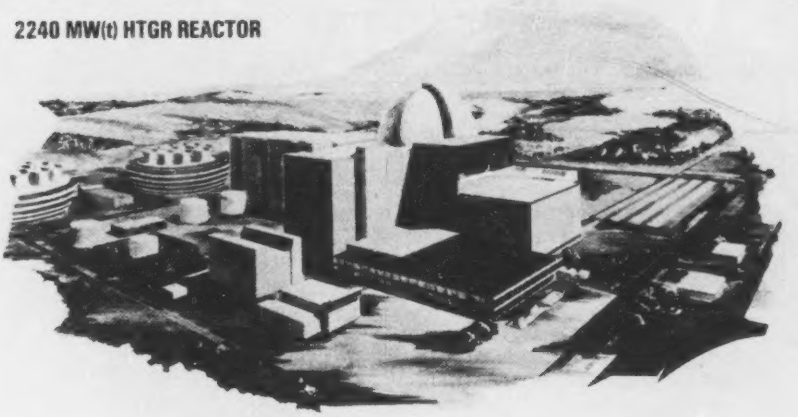
UNIQUE NUCLEAR SYSTEM IN PROVIDING HIGH TEMPERATURE PROCESS STEAM OR HEAT IN COGENERATION APPLICATIONS

- HTGR CAN PRODUCE 1000°F STEAM, COMPATIBLE WITH 57% OF CURRENT INDUSTRIAL REQUIREMENTS
- CAN DISPLACE FOSSIL FUELS USAGE, REDUCE ENVIRONMENTAL IMPACT
- FUTURE HIGHER TEMPERATURE HTGR PROCESS HEAT SYSTEMS OPEN ADDITIONAL INDUSTRIAL AND SYNFUEL APPLICATIONS TO THE USE OF CLEAN NUCLEAR PROCESS HEAT

CAN CONTRIBUTE TO ALL MAJOR ENERGY DEMAND SECTORS OF THE ECONOMY



2240 MW(t) HTGR REACTOR



OTHER BENEFITS

HIGHER LEVELS OF SAFETY, OPERATIONAL AND ENVIRONMENTAL COMPATIBILITY

- INHERENT SAFETY RESULTS IN MAXIMUM PROTECTION OF PUBLIC AND INVESTMENT, A BASIS FOR IMPROVED PUBLIC ACCEPTANCE
- REDUCED EXPOSURES OF OPERATING PERSONNEL
- LOWEST LEVELS OF GASEOUS, LIQUID AND SOLID WASTE DISCHARGE
- REDUCED COOLING WATER REQUIREMENTS
- IMPROVED SITING FLEXIBILITY

PROGRAM COMPATIBLE WITH POTENTIAL ROLE OF HTGR AS A REPLACEMENT PRODUCTION REACTOR

- ESSENTIALLY ALL NUCLEAR STEAM SYSTEM HARDWARE IDENTICAL

PROGRAM CAN BENEFIT FROM MAJOR INTERNATIONAL HTGR ACTIVITIES FOCUSED IN GERMANY AND JAPAN

STRONG INDUSTRY SUPPORT

CONCEPT HAS CONTINUING SUPPORT OF A MAJOR SEGMENT (OVER 36%) OF THE NUCLEAR UTILITY INDUSTRY AND MAJOR PROCESS INDUSTRIES.

LEAD PLANT PROGRAM DIRECTED TOWARD PRIMARY FUNDING SUPPORT FROM THE PRIVATE SECTOR, DIRECT GOVERNMENT SUPPORT LIMITED TO TRADITIONAL AREAS OF NUCLEAR R & D.

HTGR STEAM CYCLE SYSTEM

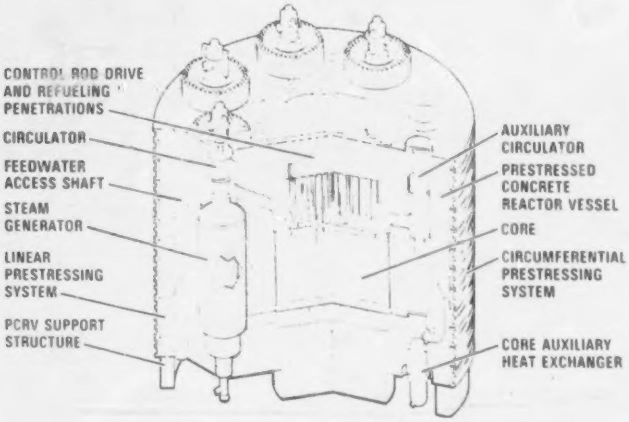
HTGR REACTOR

IN HTGR SYSTEMS, HELIUM GAS IS USED AS THE COOLANT TO REMOVE THE HEAT FROM THE CORE. IN THE HTGR-STEAM ELECTRIC/COGENERATION SYSTEM THE HELIUM IS HEATED TO ABOUT 1280°F. THIS HEAT IS TRANSFERED IN A STEAM GENERATOR TO PRODUCE STEAM FOR PROCESS USE AND/OR ELECTRICITY PRODUCTION. THE ENTIRE PRIMARY SYSTEM INCLUDING STEAM GENERATORS, HELIUM CIRCULATORS, AND AUXILIARY HEAT EXCHANGERS, IS HOUSED WITHIN THE THICK-WALLED PRESTRESSED CONCRETE REACTOR VESSEL. THE FUEL IS CONTAINED IN HEXAGONAL GRAPHITE BLOCKS, SEVERAL THOUSAND OF WHICH ARE STACKED TO MAKE UP THE REACTOR CORE. BECAUSE OF THE SYSTEMS HIGH TEMPERATURE CAPABILITY, SUPERHEATED STEAM CAN BE PRODUCED, CONTRIBUTING TO THE THERMAL EFFICIENCY OF ABOUT 40%, THE HIGHEST OF ANY NUCLEAR PLANT.

STANDARD LOOP DESIGN ALLOWS MULTIPLE UNIT RATING

USING VARYING NUMBERS OF LOOPS, HTGR SYSTEM DESIGNS ARE AVAILABLE IN RATINGS TO MATCH BROAD USER NEEDS.

- 2 LOOP – 1170 MW(t)
- 4 LOOP – 2240 MW(t)
- 6 LOOP – 3360 MW(t)

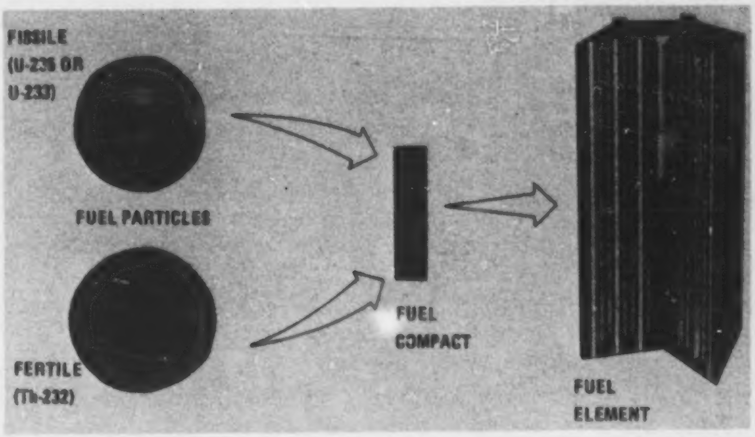

CONTROL ROD DRIVE AND REFUELING PENETRATIONS
CIRCULATOR
FEEDWATER ACCESS SHAFT
STEAM GENERATOR
LINEAR PRESTRESSING SYSTEM
PCRV SUPPORT STRUCTURE
AUXILIARY CIRCULATOR
PRESTRESSED CONCRETE REACTOR VESSEL
CORE
CIRCUMFERENTIAL PRESTRESSING SYSTEM
CORE AUXILIARY HEAT EXCHANGER

SMALL MODULAR DESIGN

SMALL (~ 250 MW(t)) MODULAR HTGR SYSTEMS TO MEET SPECIALIZED REQUIREMENTS ARE UNDER INVESTIGATION

HTGR FUEL

HTGR FUEL IS MADE UP OF TINY SPHERES OF URANIUM AND OF THORIUM, OXIDES OR CARBIDES, EACH OF WHICH IS COATED WITH PYROCARBON AND SILICON CARBIDE, WHICH SERVE TO RETAIN FISSION PRODUCTS. THESE PARTICLES ARE MIXED AND CAST INTO SMALL COMPACTS, (ABOUT 1/2 IN. DIA. X 2-1/4 IN. LONG), AND THE COMPACTS ARE SEALED INTO FUEL CAVITIES RUNNING VERTICALLY THROUGH 31 IN. HIGH HEXAGONAL GRAPHITE FUEL ELEMENTS. THE ACTIVE CORE CONSISTS OF STACKS OF THESE GRAPHITE FUEL ELEMENTS THROUGH WHICH THE HELIUM COOLANT FLOWS IN VERTICAL CHANNELS.



FUEL CYCLE COST ADVANTAGE UNDER COMPARABLE CONDITIONS

- COSTS COMPETITIVE IN STOW-AWAY MODE
- COST BENEFITS INCREASE WITH INCREASING U_3O_8 COSTS AND RECYCLE

EXTENDS U_3O_8 RESOURCE BASE

- USES 25% TO 50% LESS URANIUM THAN LWR DEPENDING ON FUEL CYCLE MODE

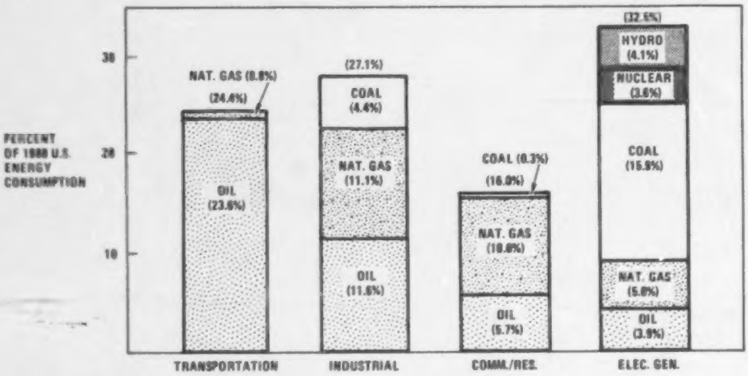
FLEXIBLE URANIUM/THORIUM FUEL CYCLE

- CAN USE EITHER LOW OR HIGH ENRICHED URANIUM CYCLE

CONGENERATION MARKET

OVER 20.6 QUADS (27%) OF THE TOTAL U.S. GROSS ENERGY CONSUMPTION IN 1980 WAS IN THE INDUSTRIAL SECTOR, WITH THE PRIMARY FUELS BEING OIL AND NATURAL GAS. TO AVOID INCREASED PRODUCTION COSTS AND TO MEET PROJECTED GROWTH IN NEW AND EXISTING INDUSTRIAL PROCESSES, INDUSTRY WILL BE FORCED TO TURN TO COAL AND NUCLEAR FOR ENERGY.

U.S. GROSS ENERGY CONSUMPTION IN 1980 – 76.3 QUADS

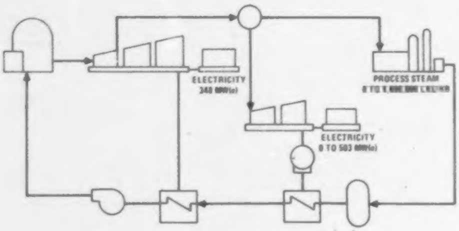


INDUSTRIAL ENERGY REQUIREMENTS

- ABOUT 13.7 QUADS (77%) OF THE REQUIREMENTS ARE AT TEMPERATURES OF 1000°F OR LESS
- ABOUT 9.0 QUADS (44%) OF THE REQUIREMENTS ARE IN THE FORM OF STEAM

PROCESS INDUSTRIES REQUIRE BOTH STEAM AND ELECTRICITY

A VARIABLE HTGR CO GENERATION PLANT CAN ACCOMMODATE MOST INDUSTRIAL APPLICATIONS

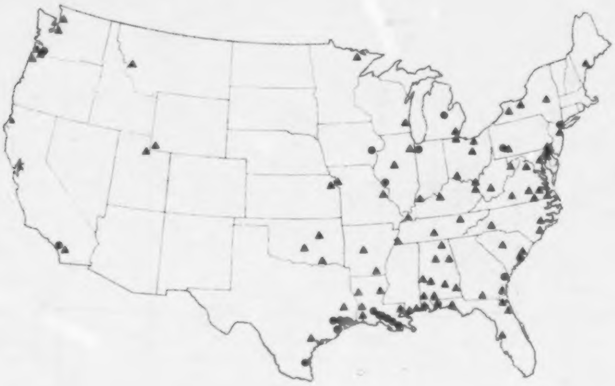


2240 MW(t) VARIABLE COGENERATION PLANT

MARKETS FOR PROCESS STEAM ARE CONCENTRATED

A RECENT DOW CHEMICAL STUDY IDENTIFIED CURRENT LOCATIONS AT WHICH COMBINED INDUSTRIAL STEAM REQUIREMENTS OFFER POTENTIAL FOR THE USE OF CENTRALIZED NUCLEAR PROCESS STEAM

▲ 119 LOCATIONS ⩾ 500,000 LB/HR PROCESS STEAM (2 MILE RADIUS)
● 19 LOCATIONS ⩾ 4,000,000 LB/HR PROCESS STEAM (10 MILE RADIUS)



A SINGLE 1170 MW(t) HTGR COGENERATION SYSTEM CAN PROVIDE UP TO 2,400,000 LB/HR OF PROCESS STEAM, FROM 175 TO 425 MW OF ELECTRICITY

FUTURE HTGR COGENERATION MARKET POTENTIAL LARGE

DURING THE 2000-2020 TIME PERIOD, THE TOTAL POTENTIAL PROCESS STEAM MARKET HAS BEEN ESTIMATED AT OVER 150 EQUIVALENT HTGR UNITS OF THE 1170 MW(t) SIZE

• MULTIPURPOSE INDUSTRIAL	58 UNITS
• SINGLE USER INDUSTRIAL	50 UNITS
• SHALE OIL PRODUCTION	10 UNITS
• COAL LIQUIDS & SYNTHETIC GAS	25 UNITS
• HEAVY OIL/TAR SAND RECOVERY	8 UNITS

AN ADDITIONAL MARKET WILL EXIST FOR HIGHER TEMPERATURE HTGR PROCESS HEAT SYSTEMS

HTGR COGENERATION APPLICATIONS

TECHNICALLY COMPATIBLE

APPLICATION STUDIES CONDUCTED DURING FY 81, FY 82 IN COOPERATION WITH MAJOR UTILITY & PROCESS INDUSTRIES SHOW THE STANDARD HTGR SYSTEM IS WELL SUITED TO MEET MOST PROCESS STEAM AND ELECTRIC POWER REQUIREMENTS

REDUCED ENERGY COSTS AND LOWERED ENVIRONMENTAL EFFECTS

FOR ALL TYPICAL APPLICATIONS, HTGR COGENERATION SYSTEMS SHOW ENERGY COSTS TO BE REDUCED BY 15 TO 40%, AND EMISSIONS SUCH AS SO_x, NO_x, CO_2, AND PARTICULATES TO BE LOWERED BY 40 TO 100%, WHEN COMPARED WITH COAL FIRED ALTERNATIVES

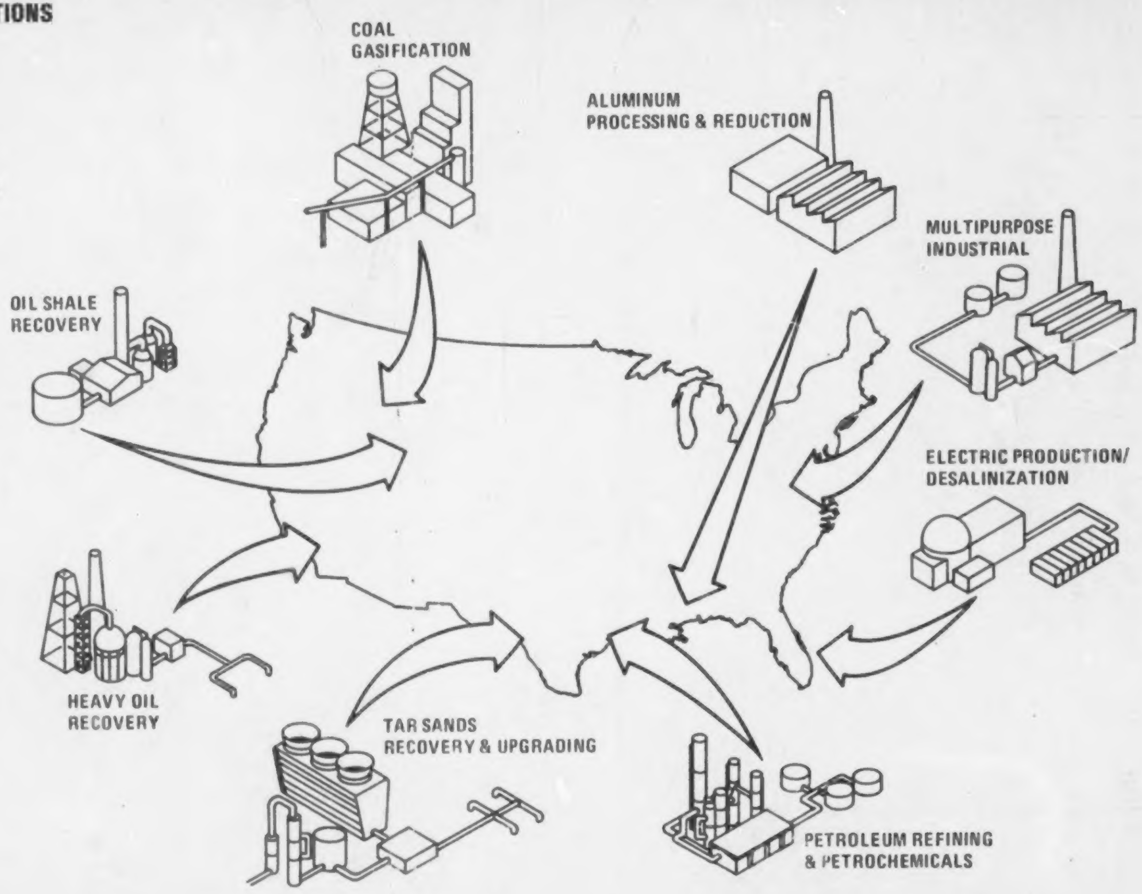
INCREASED ENERGY UTILIZATION

OVERALL ENERGY UTILIZATION INCREASED FROM 40% FOR ELECTRIC POWER GENERATION ONLY TO OVER 90% WITH NUCLEAR COGENERATION, WITH SIGNIFICANT CONSERVATION OF FOSSIL ENERGY RESOURCES

IMPEDIMENTS TO NUCLEAR PROCESS STEAM ARE INSTITUTIONAL

SELECTION OF NUCLEAR PROCESS STEAM BY INDUSTRIES CURRENTLY DIFFICULT PRINCIPALLY BECAUSE OF INSTITUTIONAL PROBLEMS

- REGULATORY UNCERTAINTIES
- SCHEDULE UNCERTAINTIES
- UNFAVORABLE NUCLEAR CLIMATE
- HIGHER INITIAL COST THAN ALTERNATIVES


COAL GASIFICATION
ALUMINUM PROCESSING & REDUCTION
MULTIPURPOSE INDUSTRIAL
OIL SHALE RECOVERY
ELECTRIC PRODUCTION/ DESALINIZATION
HEAVY OIL RECOVERY
TAR SANDS RECOVERY & UPGRADING
PETROLEUM REFINING & PETROCHEMICALS

HTGR SAFETY AND ENVIRONMENTAL FEATURES

HIGHER SAFETY LEVEL OF HTGR RESULTS FROM INHERENT PHYSICAL AND NUCLEAR PROPERTIES

- MASSIVE GRAPHITE CORE PROVIDES SLOW TEMPERATURE RESPONSE, DOES NOT REQUIRE FAST ACTING SHUTDOWN SYSTEM
- GRAPHITE CORE AND CERAMIC FUEL STABLE TO EXTREME TEMPERATURES
- NON REACTIVE HELIUM COOLANT
- MASSIVE , REDUNDANT, PRESTRESSED CONCRETE REACTOR VESSEL
- INHERENT SHUTDOWN MECHANISMS (LARGE CORE NEGATIVE TEMPERATURE COEFFICIENT)

INHERENT FEATURES ARE SUPPLEMENTED WITH ENGINEERED SAFETY SYSTEMS

- INDEPENDENT AUXILIARY COOLING SYSTEM
- INDEPENDENT EMERGENCY REACTIVITY SHUTDOWN SYSTEM
- REACTOR CONTAINMENT BUILDING

AMPLE TIME TO RESPOND TO LOSS OF CORE COOLING

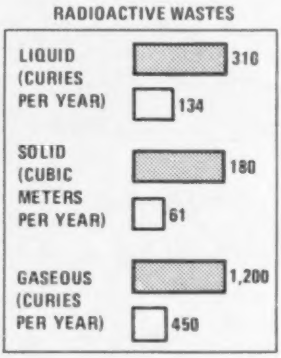
- HOURS INSTEAD OF MINUTES BEFORE DAMAGE TO CORE

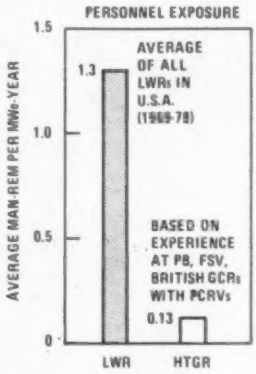
REDUCED RADIOACTIVITY WASTES

HELIUM COOLED HTGR PLANTS INHERENTLY RELEASE INTO THE PLANT PROCESS STREAMS LESS RADIOACTIVITY AND AT LOWER CONCENTRATIONS THAN AN LWR.

SIGNIFICANTLY REDUCED OPERATOR EXPOSURE

EXPERIENCE AT PEACH BOTTOM I, FORT ST. VRAIN AND GAS-COOLED REACTORS IN THE U.K. INDICATE THAT RADIATION EXPOSURES TO OPERATING AND MAINTENANCE PERSONNEL WILL BE ABOUT 1/10 OF THOSE FOR AN LWR.





HTGR ADVANCED SYSTEMS

THE HTGR STEAM CYCLE WILL PROVIDE A TECHNICAL BASE FOR ADVANCED SYSTEMS WITH HIGHER OPERATING TEMPERATURES. TWO SUCH SYSTEMS ARE THE PROCESS HEAT AND THE GAS TURBINE HTGR.

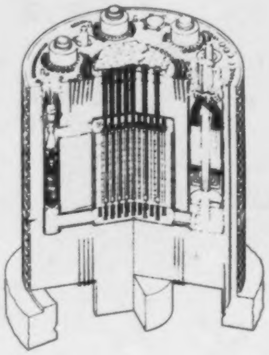
HTGR-PROCESS HEAT

THE PROCESS HEAT HTGR PROVIDES HELIUM CORE OUTLET TEMPERATURES OF 1472° TO 1652°F. AN INTERMEDIATE HEAT EXCHANGER TRANSFERS THE HEAT TO A SECONDARY HELIUM LOOP INCORPORATING A REFORMER THAT CAN BE USED TO REACT STEAM AND METHANE TO FORM HYDROGEN AND CARBON MONOXIDE, A REDUCING GAS THAT CAN BE INTEGRATED INTO SUCH PROCESSES AS OIL SHALE RETORTING, COAL LIQUEFACTION, AND COAL GASIFICATION, TO PRODUCE

- TRANSPORTATION LIQUIDS
- AMMONIA
- SYNTHETIC PIPELINE GAS

AT HIGHER CORE OUTLET TEMPERATURES (1652° TO 1832°F) THE REFORMING REACTION CAN BE PERFORMED MORE EFFICIENTLY AND A DIRECT STEAM-COAL REACTION CAN BE UTILIZED TO PRODUCE

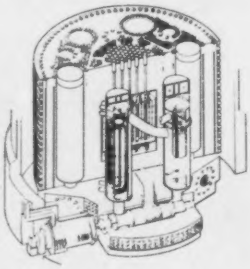
- HIGH BTU GAS
- HYDROGEN (FROM THERMOCHEMICAL WATER SPLITTING)



HTGR-GAS TURBINE ELECTRIC/COGENERATION

THE GAS TURBINE HTGR USES THE HELIUM AS THE COOLANT, AND ALSO AS THE WORKING FLUID WITH AN INTEGRATED DIRECT-CYCLE GAS TURBINE. HELIUM CORE OUTLET TEMPERATURES ARE IN THE 1472° TO 1562°F RANGE. A "BRAYTON" CYCLE IS USED WITH THE GAS TURBINE WHICH RESULTS IN A HIGH WASTE HEAT REJECTION TEMPERATURE (300°F).

- INTERMEDIATE TEMPERATURE COGENERATION
- ECONOMIC DRY COOLING IN ARID AREAS
- THERMAL EFFICIENCIES TO 50% (WITH BOTTOMING CYCLE)



3

TECHNOLOGY BACKGROUND

UNITED STATES PROGRAM

SUBSTANTIAL EXPERIENCE, TECHNOLOGY, AND TEST AND MANUFACTURING FACILITIES CURRENTLY EXIST IN U.S.

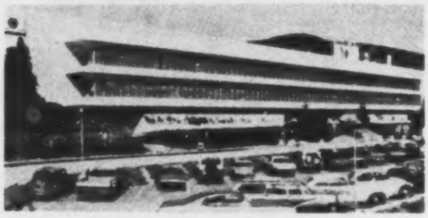
PEACH BOTTOM UNIT I

40 MW(e) PEACH BOTTOM UNIT 1 HTGR WAS OPERATED SUCCESSFULLY BY PHILADELPHIA ELECTRIC COMPANY FROM 1967 TO 1974, WHEN PLANT WAS SHUT DOWN FOR DECOMMISSIONING AFTER COMPLETING PLANNED DEMONSTRATION PROGRAM.

TEST FACILITIES

HTGR TEST FACILITY COMPOUND, INCLUDING AIR FLOW TEST FACILITY, COMPONENT TEST TOWER, PCRV MODELS, TENDON TEST FACILITY, PCRV WIRE-WINDING MACHINE, AND HELIUM CIRCULATOR TEST FACILITY.

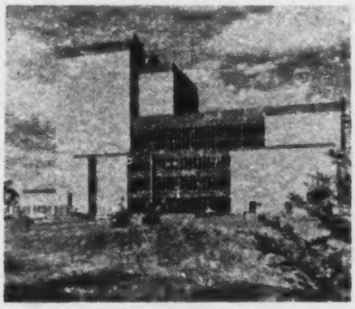
MANUFACTURING FACILITIES

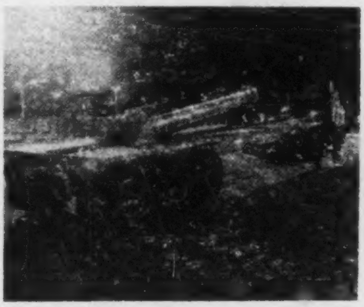


MANUFACTURING FACILITIES AVAILABLE FOR COATED PARTICLES AND FUEL ROD PRODUCTION AS WELL AS SPECIALIZED REACTOR COMPONENTS.

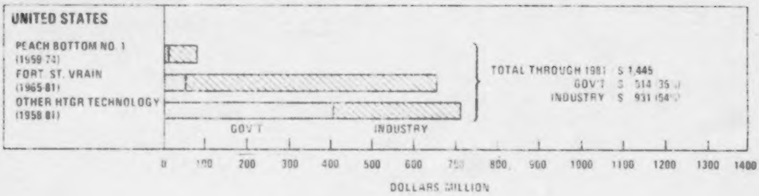
FORT ST. VRAIN

- ACHIEVED 100% POWER OPERATION ON NOVEMBER 6, 1981, FOLLOWED BY 60 CONTINUOUS HOURS OF OPERATIONAL TESTING AT FULL POWER
  - NO CORE FLOW OR TEMPERATURE FLUCTUATIONS OBSERVED DURING RISE-TO-POWER TESTING OR DURING FULL-POWER OPERATION
  - GENERATED 325 MW OF ELECTRICAL CAPACITY AND OPERATED AT OVER 38.5% THERMAL EFFICIENCY, WITH ONE FEEDWATER HEATER TEMPORARILY OUT OF SERVICE
  - ALL PLANT SYSTEMS AND COMPONENTS PERFORMED AT OR NEAR DESIGN CONDITIONS
- HAS GENERATED OVER 2.5 BILLION KW HRS OF NET ELECTRICAL ENERGY TO DATE
- FUEL PERFORMANCE EXCELLENT, ACTIVITY IN HELIUM COOLANT LESS THAN 2% OF DESIGN LIMIT
- AVERAGE ANNUAL PERSONNEL EXPOSURE RATE SIGNIFICANTLY LESS THAN IN LWR PLANTS, DESPITE VIRTUALLY UNLIMITED PERSONNEL ACCESS INTO REACTOR BUILDING AND ABSENCE OF SECONDARY CONTAINMENT
- DISCHARGED FUEL SHIPPED TO HTGR DRY STORAGE FACILITY AT IDAHO CHEMICAL PROCESSING PLANT





PROGRAM FUNDING THROUGH 1981



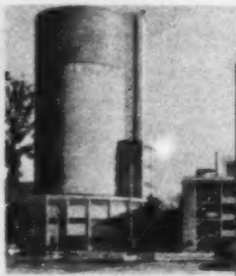
INTERNATIONAL PROGRAM

EXPERIENCE

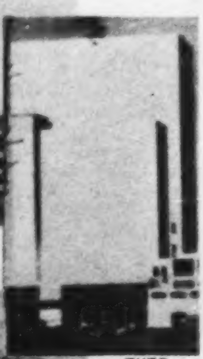
SUBSTANTIAL INTERNATIONAL EXPERIENCE ON GAS-COOLED REACTOR TECHNOLOGY SUPPORTS U.S. PROGRAM

GERMANY

- AVR - 15 MW(e) HTGR WITH PEBBLE BED FUEL, OPERATED SINCE 1967 STARTUP
- THTR - 300 MW(e) HTGR WITH PEBBLE BED FUEL - CONSTRUCTION 70% COMPLETE - STARTUP PLANNED FOR 1983
- COMPREHENSIVE HTGR PROGRAM WITH STRONG SUPPORT FROM COAL/UTILITY INDUSTRIES
- CURRENT FUNDING LEVEL $200 MILLION



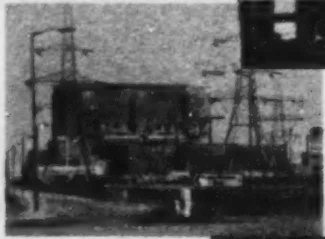
AVR



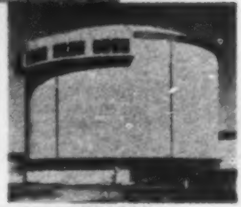
THTR

UNITED KINGDOM

- HARTLEPOOL - FIRST OF 625 MW(e) AGRs WITH MULTICAVITY PCRV
- DRAGON - FIRST HTGR, OPERATED FROM 1964-1975
- OVER 525 REACTOR YEARS OF OPERATING EXPERIENCE WITH GAS-COOLED REACTORS
- HEYSHAM - TWO UNIT 611 MW(e) AGR PLANT COMMITTED TO CONSTRUCTION IN 1981, FOR OPERATION IN 1987-1988



HARTLEPOOL



DRAGON

FRANCE

- OVER 95 REACTOR YEARS OF OPERATING EXPERIENCE
- CARMEN II FACILITY - CORE-FLOW AND HOT DUCT TESTS CONDUCTED - CAPABILITY FOR STEAM GENERATOR BOILING STABILITY TESTS

JAPAN

- VHTR — 50 MW(t) HTGR WITH 1000°C CORE OUTLET TEMPERATURE UNDER DEVELOPMENT CONSTRUCTION START TARGETED FOR 1986
- IN-PILE AND OUT-OF-PILE HIGH TEMPERATURE TEST LOOPS/HENDEL 10MW HELIUM LOOP FACILITY
- CURRENT FUNDING LEVEL $35 MILLION

HENDEL

TECHNICAL EXCHANGE AGREEMENTS

RELEVANT HTGR EXPERIENCE IS BROUGHT INTO THE U.S. PROGRAM THROUGH GOVERNMENT AND INDUSTRY EXCHANGE AGREEMENTS

EUROPE

- U.S. – GERMANY – SWITZERLAND – FRANCE "UMBRELLA AGREEMENT" ON GAS COOLED REACTORS
  GOVERNMENT LEVEL TECHNICAL COOPERATION AGREEMENT

GERMANY

- GA – HOCHTEMPERATUR REAKTORBAU (HRB)
  LICENSE AGREEMENT ON HTGR SYSTEMS AND COMPONENTS
- GA – HOCHTEMPERATUR BRENNELEMENT GMBH (HOBEG)
  LICENSE AGREEMENT ON HTGR FUEL
- GCRA – HOCHTEMPERATUR REAKTOR GESELLSCHAFT (HRG)
  MEMO OF COOPERATION ON HTGR WITH GERMAN UTILITY GROUP

SWITZERLAND

- GA – SULZER BROTHERS
  TECHNICAL EXCHANGE AGREEMENT ON HEAT EXCHANGERS

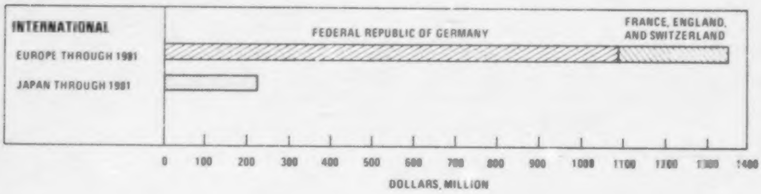
UK

- GA – CENTRAL ELECTRICITY GENERATING BOARD (CEGB)
  TECHNICAL EXCHANGE AGREEMENT ON GAS COOLED REACTORS
- GA – NATIONAL NUCLEAR CORP. (NNC)
  TECHNICAL EXCHANGE AGREEMENT ON GAS COOLED REACTORS

JAPAN

- GA – KAWASAKI HEAVY INDUSTRIES (KHI)
  LICENSE AGREEMENT ON HTGR SYSTEMS FOR JAPANESE VHTR PROGRAM
- GA – JAPAN ATOMIC ENERGY RESEARCH INSTITUTE (JAERI)
  TECHNICAL COOPERATION AGREEMENT ON HTGR
- GA – JAPAN ASSOCIATION FOR NUCLEAR PROCESS HEAT (JANP)
  TECHNICAL COOPERATION AGREEMENT ON HTGR APPLICATIONS

PROGRAM FUNDING THROUGH 1981



HTGR PROGRAM DESCRIPTION

THE CURRENT GOVERNMENT/INDUSTRYHTGR PROGRAM, WHICH IS FOCUSED ON THE DEVELOPMENT AND DEMONSTRATION OF A COMMERCIAL-SCALE HTGR STEAM CYCLE SYSTEM, HAS BROAD INDUSTRY, USER, AND NATIONAL LABORATORY INVOLVEMENT.

GENERAL ATOMIC, THE WORLD LEADER IN HTGR TECHNOLOGY, IS THE LEAD INDUSTRIAL FIRM INVOLVED IN THE PROGRAM. HOWEVER, OTHER EXPERIENCED INDUSTRIAL COMPANIES ARE ALSO DIRECTLY INVOLVED IN KEY AREAS.

- GENERAL ELECTRIC COMPANY
- COMBUSTION ENGINEERING COMPANY
- BECHTEL GROUP INC.
- UNITED ENGINEERS & CONSTRUCTORS

HTGR PROGRAM ACTIVITIES ARE ALSO CONDUCTED AT NATIONAL LABORATORIES.

- OAK RIDGE NATIONAL LABORATORY
- LOS ALAMOS NATIONAL LABORATORY

GAS-COOLED REACTOR ASSOCIATES (GCRA), REPRESENTS THE UTILITY/USER INTERESTS IN SUPPORT OF THE PROGRAM, AND PERFORMS AN OVERALL PROGRAM INTEGRATION ACTIVITY FOR THE GOVERNMENT.

LEAD PLANT PROGRAM

THE MAJOR FRACTION OF THE HTGR PROGRAM ACTIVITIES ARE DIRECTED TOWARD TECHNOLOGY DEVELOPMENT AND DESIGN SUPPORT ACTIVITIES TO ALLOW A COMMITMENT TO AN HTGR LEAD PLANT PROJECT

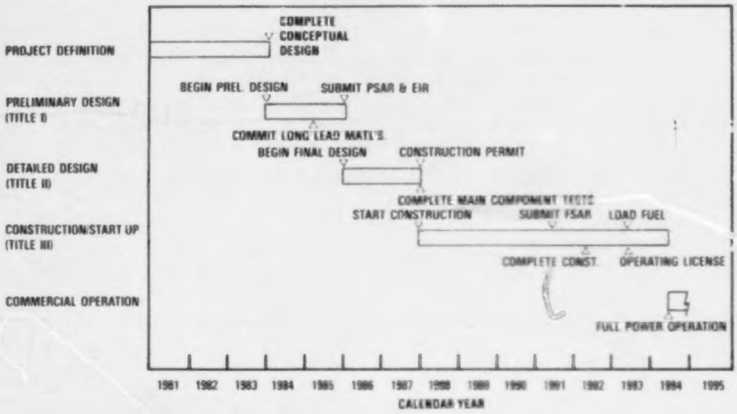
OBJECTIVES

THE MAJOR OBJECTIVES OF THE LEAD PLANT PROJECT INCLUDE

- DEMONSTRATION OF FULL COMMERCIAL SCALE HTGR SYSTEMS AND COMPONENTS INCLUDING FEATURES INCORPORATING TECHNOLOGY EVOLUTION AND FORT ST. VRAIN OPERATIONAL EXPERIENCE
- ESTABLISHING THE LICENSING CRITERIA FOR FOLLOW-ON COMMERCIAL HTGR SYSTEMS
- CONFIRMING INCENTIVES OF THE HTGR NUCLEAR SYSTEM FOR ELECTRIC PRODUCTION AND COGENERATION
- ESTABLISHING A BROAD INDUSTRIAL INFRASTRUCTURE TO SUPPORT A SUBSEQUENT COMMERCIAL HTGR INDUSTRY

SCHEDULE

THE LEAD PLANT PROGRAM IS DIRECTED TOWARD COMPLETION OF PROJECT DEFINITION PHASE ACTIVITIES IN FY 1983, FULL POWER OPERATION IN 1994



LEAD PLANT FUNDING APPROACH

A KEY PROJECT DEFINITION PHASE TASK IS TO DEVELOP MANAGEMENT, FUNDING, AND RISK SHARING ARRANGEMENTS

- INDUSTRY TO BEAR THE MAJOR PORTION OF THE LEAD PROJECT COSTS
- DIRECT GOVERNMENT PARTICIPATION LIMITED TO SUPPORT OF DESIGN AND DEVELOPMENT

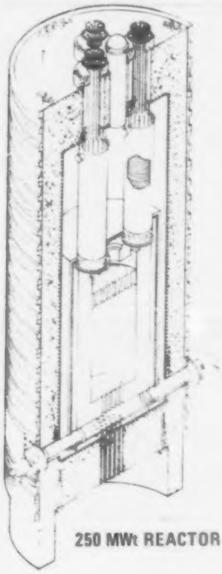
LEAD PLANT FUNDING (1981 $)

PHASE	GOV'T	INDUSTRY	TOTAL
PROJECT DEFINITION ('82-'83)	80	6	86
PRELIMINARY DESIGN ('84-'85)	148	23	171
DETAILED DESIGN ('86-'87)	176	71	247
CONSTRUCTION/STARTUP ('88-'94)	50	1360	1410
	$454	$1,460	$1,914
	(24%)	(76%)	

OTHER PROGRAM ACTIVITIES

IN ADDITION TO PRIMARY EFFORTS ON BASE TECHNOLOGY DEVELOPMENT AND THE STEAM ELECTRIC/COGENERATION LEAD PLANT PROJECT DESIGN AND APPLICATIONS, THE HTGR PROGRAM ALSO INCLUDES OTHER SECONDARY AND COMPLIMENTARY ACTIVITIES.

- CONCEPTUAL DESIGN OF HIGHER-TEMPERATURE VERSIONS OF THE HTGR, I.E., REFORMING PROCESS HEAT HTGR AND DIRECT CYCLE GAS TURBINE HTGR SYSTEMS.
- FEASIBILITY ASSESSMENT OF SMALL (APPROX. 250 MW(t)), MODULAR HTGR SYSTEMS FOR ELECTRIC/COGENERATION AND PROCESS HEAT APPLICATIONS.
- INVESTIGATION OF WASTE TREATMENT AND SPENT FUEL STORAGE FOR NEAR-TERM CLOSURE OF THE HTGR FUEL CYCLE, PLUS CONTINUED DEVELOPMENT OF TECHNOLOGY FOR EVENTUAL REPROCESSING OF HTGR-TYPE URANIUM/THORIUM FUEL ELEMENTS.
- DEVELOPMENT OF SAFETY/LICENSING CRITERIA SPECIFIC TO THE HTGR, AND REVIEW OF LONG-RANGE RESEARCH PLANS FOR VERIFICATION OF HTGR SAFETY.
- INTERNATIONAL COOPERATION



250 MWt REACTOR

THE SMALL STEAM-CYCLE/ COGENERATION HTGR SYSTEM CONSISTS OF A 250 MW(t) REACTOR CORE AND PRIMARY LOOPS HOUSED IN A PRE-STRESSED CONCRETE REACTOR VESSEL. THE PRIMARY COOLANT LOOP CONTAINS ONCE-THROUGH STEAM GENERATORS, LOCATED IN THE UPPER PORTION OF THE PCRV, AND HORIZONTALLY MOUNTED HELIUM CIRCULATORS, DRIVEN BY SYNCHRONOUS ELECTRIC MOTORS. THIS EQUIPMENT IS ARRANGED IN THE VESSEL SO AS TO PROMOTE NATURAL CIRCULATION SHUTDOWN COOLING OF THE CORE. THE CONTROL RODS ENTER THE REACTOR CORE FROM THE VESSEL BOTTOM

UTILITY AND INDUSTRY SUPPORT

ELECTRIC UTILITY SUPPORT THRU GCRA

- IN 1978 A UTILITY ORGANIZATION, GAS-COOLED REACTOR ASSOCIATES (GCRA), WAS FORMED TO PROVIDE SUPPORT AND GUIDANCE TO PROGRAM. GCRA UTILITIES CURRENTLY REPRESENT OVER 25% OF INSTALLED ELECTRIC GENERATING CAPACITY IN UNITED STATES, OVER 25% OF ON-LINE NUCLEAR CAPACITY AND ABOUT 40% OF NUCLEAR CAPACITY NOW UNDER CONSTRUCTION.

ARIZONA PUBLIC SERVICE
CITY OF TACOMA
COLORADO-UTE ELECTRIC ASSOCIATION
DELMARVA POWER & LIGHT
EMPIRE STATE ELEC. ENERGY RESEARCH CORP.
    CENTRAL HUDSON GAS & ELECTRIC
    CONSOLIDATED EDISON
    LONG ISLAND LIGHTING
    NEW YORK STATE ELECTRIC & GAS
    NIAGARA MOHAWK POWER
    ORANGE & ROCKLAND UTILITIES
    ROCHESTER GAS & ELECTRIC
FLORIDA POWER & LIGHT
GULF STATES UTILITIES
HELIUM BREEDER ASSOCIATES
IDAHO POWER
NORTHEAST UTILITIES
    CONNECTICUT LIGHT & POWER
    HARTFORD ELECTRIC LIGHT
    WESTERN MASSACHUSETTS ELECTRIC
    HOLYOKE WATER POWER
PACIFIC GAS & ELECTRIC
PACIFIC POWER & LIGHT
PHILADELPHIA ELECTRIC
PUBLIC SERVICE OF COLORADO
PUBLIC SERVICE OF NEW MEXICO
PUBLIC SERVICE ELECTRIC & GAS
PUGET SOUND POWER & LIGHT
SALT RIVER PROJECT
SAN DIEGO GAS & ELECTRIC
TENNESSEE VALLEY AUTHORITY

INDUSTRIAL USER SUPPORT

- IN 1979 A GROUP OF MAJOR INDUSTRIAL FIRMS FORMED A PROCESS HEAT USERS GROUP TO SUPPORT CONTINUED DEVELOPMENT OF HTGR. MOST OF THESE COMPANIES MERGED INTO PROCESS HEAT ADVISORY COMMITTEE ESTABLISHED BY GCRA IN 1981.

ALLIED CHEMICAL
CONSOLIDATED NATURAL GAS SERVICE
GULF OIL
INLAND STEEL
KAISER ALUMINUM & CHEMICAL
MOBIL RESEARCH & DEVELOPMENT
OWENS-CORNING FIBERGLASS
SCALLOP COAL
UNITED GAS PIPE LINE

IN SEPTEMBER 1981 GCRA SPONSORED ITS THIRD ANNUAL HTGR CONFERENCE, WHICH WAS ATTENDED BY OVER 300 REPRESENTATIVES OF INDUSTRY, GOVERNMENT AND UTILITIES FROM EIGHT COUNTRIES.

FY 81 HTGR PROGRAM ACCOMPLISHMENTS

HTGR STEAM ELECTRIC/COGENERATION LEAD PROJECT ACTIVITIES

- ESTABLISHED REFERENCE DESIGN
- COMPLETED 20% OF NUCLEAR SYSTEM CONCEPTUAL DESIGN
- COMPLETED PRELIMINARY SITE-SPECIFIC STUDIES FOR FLORIDA POWER AND LIGHT, MID-ATLANTIC, AND INTER-MOUNTAIN CANDIDATE PROJECTS
- COMPLETED APPLICATION STUDIES – OIL SHALE, HEAVY OIL, CHEMICAL AND REFINING

BASE TECHNOLOGY DEVELOPMENT

- COMPLETED PRIORITIZED DESIGN DATA NEED PACKAGES
- SELECTED REFERENCE FUEL FOR LEU-TH FUEL CYCLE
- INITIATED CONSTRUCTION OF DEVELOPMENTAL COATER FOR LEU FUEL PARTICLES
- RECOMMENDED ENHANCED SAFETY FEATURES

ADVANCED SYSTEMS

- COMPLETED APPLICATION STUDIES – SYNTHETIC FUEL PRODUCTION

SPENT FUEL TREATMENT PROGRAM

- COMPLETED INSTALLATION OF OFF-GAS MONITORING SYSTEM

NRC SAFETY/LICENSING ACTIVITIES

REVIEWED LONG-RANGE RESEARCH PLAN FOR HTGR SAFETY CONFIRMATION

FY-81 NATIONAL PROGRAM FUNDING

FOR HTGR APPLICATIONS AND BASE TECHNOLOGY	$40 MILLION
FOR SPENT FUEL TREATMENT PROGRAM	$ 3 MILLION
FOR NRC SAFETY/LICENSING ACTIVITIES	$ 4 MILLION

FY 82 HTGR PROGRAM

HTGR STEAM ELECTRIC/COGENERATION LEAD PROJECT ACTIVITIES

- COMPLETE 60% OF NUCLEAR STEAM CONCEPTUAL DESIGN
- COMPLETE PRELIMINARY SITE SPECIFIC STUDIES – GULF COAST REFINERY/CHEMICAL, ALUMINIUM PROCESSING AND REFINING CANDIDATE PROJECTS
- COMPLETE PROJECT DECISION PACKAGES
- COMPLETE PRELIMINARY MANAGEMENT PLAN

BASE TECHNOLOGY DEVELOPMENT

- COMPLETE REVIEW OF DESIGN AND DEVELOPMENT PROGRAMS
- INITIATE NON-DESTRUCTIVE EXAMINATION OF TEST FUEL ELEMENT FROM FSV
- PREPARE TEST FACILITY FOR MAIN CIRCULATOR BEARINGS AND SEALS TESTS
- INITIATE AIR FLOW TESTS OF UPPER AND LOWER CORE PLENUMS

ADVANCED SYSTEMS

- PERFORM PRE-CONCEPTUAL DESIGN AND FEASIBILITY STUDIES ON SMALL STEAM-CYCLE AND PROCESS HEAT HTGRS
- COMPLETE ECONOMIC EVALUATION OF LARGE HTGR PROCESS HEAT APPLICATIONS

SPENT FUEL TREATMENT PROGRAM

- COMPLETE TESTS ON HEAD END TREATMENT OF GERMAN PEBBLE BED FUEL

NRC SAFETY/LICENSING ACTIVITIES

- COMPLETE TOPICAL REPORTS ON HTGR SAFETY FOR NRC REVIEW

FY-82 NATIONAL PROGRAM FUNDING:	
FOR HTGR APPLICATIONS AND BASE TECHNOLOGY	$35 MILLION
FOR SPENT FUEL TREATMENT PROGRAM	$ 3 MILLION
FOR NRC SAFETY/LICENSING ACTIVITIES	$ 4 MILLION

RECOMMENDED FY 83 HTGR PROGRAM

HTGR STEAM ELECTRIC/COGENERATION LEAD PROJECT ACTIVITIES

- COMPLETE CONCEPTUAL DESIGN, SCHEDULE AND COST ESTIMATES
- COMPLETE MANAGEMENT PLAN
- COMPLETE PRELIMINARY SITE REVIEW AND LICENSING DOCUMENT
- COMPLETE PRELIMINARY ENVIRONMENTAL IMPACT STATEMENT
- IDENTIFY LEAD PROJECT AND SITE
- LET MAJOR SUBCONTRACTS FOR DESIGN OF STEAM GENERATORS AND MOTORS/MOTOR CONTROLLERS FOR MAIN AND AUXILIARY CIRCULATORS

BASE TECHNOLOGY DEVELOPMENT

- PERFORM HOT-CELL DESTRUCTIVE EXAMINATION OF FSV TEST FUEL ELEMENT
- START MAIN CIRCULATOR BEARINGS AND SEALS TESTS
- INITIATE FULL-SCALE CORE AUXILIARY HEAT EXCHANGER TESTS
- SELECT CORE SUPPORT STRUCTURE GRAPHITE AND CONFIRM MATERIALS DATA

ADVANCED SYSTEMS

- COMPLETE PRECONCEPTUAL DESIGN OF SMALL REACTOR FOR COGENERATION AND PROCESS HEAT APPLICATIONS
- COMPARE DESIGN, ECONOMICS, AVAILABILITY AND LICENSABILITY OF MONOLITHIC AND MODULAR PLANTS

SPENT FUEL TREATMENT PROGRAM

- COMPLETE FLUID-BED BURNER OFF-GAS TREATMENT TEST PROGRAM
- CONTINUE LEAD PLANT SPENT FUEL TRANSPORTATION/STORAGE/PROCESSING STUDIES

NRC SAFETY/LICENSING ACTIVITIES

- INTERACT WITH NRC ON SPECIFIC SITE REVIEW AND GENERIC LICENSING ISSUES

RECOMMENDED FY-83 NATIONAL PROGRAM FUNDING:		
FOR HTGR PROJECT AND BASE TECHNOLOGY		$45 MILLION
– BASE TECHNOLOGY DEVELOPMENT	$24 MILLION	
– LEAD PLANT DESIGN AND APPLICATION STUDIES	$16 MILLION	
– ADVANCED SYSTEMS	$ 5 MILLION	
FOR SPENT FUEL TREATMENT PROGRAM		$ 3 MILLION
FOR NRC SAFETY/LICENSING ACTIVITIES		$ 4 MILLION

Mr. VOLKMER. Thank you, Dr. Agnew.

And, Mr. Richards.

STATEMENT OF ROBERT B. RICHARDS, GENERAL MANAGER, ADVANCED REACTOR SYSTEMS DEPARTMENT, ENERGY SYSTEMS AND TECHNOLOGY DIVISION, GENERAL ELECTRIC CO.

Mr. RICHARDS. Thank you, Mr. Chairman.

I am Robert B. Richards, general manager of the advanced reactor systems department of General Electric, and our department's charter assigns to us the responsibility for company activities in the high temperature gas reactor field.

GE has been a participant in this field for about the past 7 years, and as we have stated in earlier submittals, out interest is particularly keen for the potential of this reactor type to attain very high working temperatures that would make it possible to substitute as a heat source the HGTR for other uses, other materials such as coal, oil or gas.

We have been working with the GCRA on this program now for a number of years. The program is focused on a lead project, and this lead project will be guiding the design and the development work that would provide, eventually, a field demonstration of cogeneration. During the past year in particular, the program has identified a number of interesting lead plant possibilities and sites, and we think the program should continue to investigate these further in the year ahead.

One particular study that was started, and which we are participating in, during the past year is the taking a look at what we call a modular HTGR. This is a small capacity HGTR of about 250 megawatts thermal, but we have been looking at how to design and actually factory build one of these modular units. And it could be that they could be very easily shipped on a rail flatcar or something to the site, and we think that there are cost reductions by the use of prefabricating these units, and they would be employed in multiple units at a particular site. And this way we feel that we would also improve the availability and the capacity factor of the total system that way.

Now, we think this program should continue. We are in a feasibility stage now, but it is interesting enough and we believe that it has got some good possibilities ahead. We think the program should continue to study this and eventually, in the next year or so, establish the feasibility of this program.

We can't say, today, just what one of these modulars would cost. We have much more work to do on it, but we think it is a very, very exciting development in the whole process heat area.

I think, in summary, the program sponsored by DOE and integrated by GCRA has made excellent progress over the last year, and I think that they have identified many possibilities, many opportunities, for process heat applications and cogeneration applications. With that I will conclude and will stand ready to answer any questions you might have.

[The prepared statement of Mr. Richards follows:]

TESTIMONY OF

ROBERT B. RICHARDS
GENERAL MANAGER, ADVANCED REACTOR SYSTEMS DEPARTMENT
ENERGY SYSTEMS AND TECHNOLOGY DIVISION
GENERAL ELECTRIC COMPANY

ON

DOE FY 1983 BUDGET REQUEST

BEFORE THE

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

MARCH 17, 1982

94-725 O—82——23

My name is Robert B. Richards. I am General Manager of the Advanced Reactor Systems Department of the General Electric Company. The charter of the department includes responsibility for our Company's activities in the field of High Temperature Gas Cooled Reactors (HTGR). We are pleased to have this opportunity to submit our views on the role of this technology in the nation's energy future.

For many years, DOE has supported design and R&D for gas cooled reactors. Gas Cooled Reactor Associates (GCRA) have also contributed financial support and have promoted such reactors for process heat/electricity co-generation and eventually very high temperature process heat applications.

General Electric has been a participant in the program for the past seven years. General Electric has been interested primarily in the potential of the system for attaining the high working temperatures that would be applicable to numerous process industries as a substitute for the combustion of coal, oil, or gas.

Our reactor and process heat system support activity is carried out at the department's headquarters in Sunnyvale, California.

In addition General Electric's Energy Systems and Technology Division conducts materials research and testing programs in its laboratories in Schenectady, New York. The objective of this latter program is to identify and qualify advanced materials that can sustain the very high temperatures possible in the gas cooled reactor.

The nuclear power business in its present state has many institutional problems that have slowed the commitment to new nuclear reactors. The timing and the need for HTGR commercial application is certainly delayed. However, any continuing HTGR program should develop a sound design and technology base that industry could utilize at some future time in selected applications for co-generation and process heat.

We believe a reasonable HTGR design technology and development program depends on continued work to:

(a) Evaluate the potential markets for high temperature process heat through a co-generation approach.

(b) Evaluate potential markets for very high temperature single-purpose applications in the process industries over the long term.

The design and R&D efforts in the program should be conducted to support the potential needs identified in (a) and (b). The present GCRA program focuses on a lead project that would guide the design and development work and provide a field demonstration of co-generation. During the past year, the program has identified a number of interesting lead plant possibilities and these should be investigated further.

The design and R&D program must of course be closely integrated with the needs and requirements of the process industries and it will be essential that these industries continue to be closely involved during this development period. The program should also have the objective of establishing a technology base that would permit a decision by the private sector to move ahead with a commercial commitment at some appropriate future time.

We believe the eventual pay-off for HTGR process heat applications will be realized in two areas:

(1) Major savings in fossil fuels that would otherwise be combusted to provide process heat.

(2) Major reductions in environmental releases.

During the past year, DOE and GCRA have initiated a design study of small capacity "modular" HTGRs. Such units might be factory built and shipped to a user site. The use of prefabricated multiple units might well reduce construction and licensing costs. Certainly, the cost of demonstration of this technology might be substantially reduced.

If DOE support continues to be available, we believe the "modular" program should continue to the point where engineering feasibility and economics could be established. Again, it will be important for the process industries to participate in these developments together with GCRA.

The present DOE/GCRA program has developed an effective technical exchange with organizations in Germany that have been pursuing HTGR process heat applications. We believe these exchanges should be continued and expanded where appropriate. The benefits to both countries could be substantial.

In summary, we believe the DOE/GCRA program has made excellent progress over the last several years in identifying opportunities for process heat applications and the reactor designs that could serve such applications.

We in GE will continue to participate in DOE/GCRA and bring whatever resources required to the program to contribute to its eventual success.

We appreciate your kind attention to our views on the HTGR program and stand ready to answer any questions you may have.

Mr. **Volkmer**. Thank you very much, Mr. Richards.

Mr. Lowery, do you have any questions?

Mr. **Lowery**. Thank you, Mr. Chairman, indeed I do.

In his testimony, Thomas Dillon of the Department of Energy commented that the reason DOE zeroed the HGTR program was the absence of a firm commitment of a utility to purchase an HTGR plant, the slowdown in marketing of nuclear reactors in general, and the overall need for budget restraint. He went on to say that given a firm commitment from utilities and an acceptable funding package, DOE would then reconsider.

Now, the last time we had hearings on this subject I submitted some written questions to the Department of Energy. Let me amplify further on those comments that were made yesterday by Dr. Dillon.

In answer to questions on termination of the Government funding for HTGR, DOE responded, and I quote, "In the absence of a utility/user commitment to purchase an HTGR plant the decision was made to withdraw Federal support for this program in fiscal year 1983."

I have some problems with that. DOE made the statement despite the fact they knew that 25 percent of the Nation's utilities have made commitments in support of the technology as well as private utilities' intentions to fund 75 percent of the proposed lead plant project, with the Government picking up the other 25 percent of the front-end R. & D. costs.

Now, my question to the panel—to each of you if you would comment, please: Do you feel that this is a fair evaluation by DOE of a utility commitment to the HTGR project?

Mr. **Walker**. I will lead off, Congressman.

As a representative of the utility industry I think our testimony and the diligence with which we have worked on this concept shows that we do have a real interest and we have a variety of interests in it. I don't have to tell any of the members of the subcommittee the difficulty that our industry is having in making commitments for any kind of a plant, whether it be a coal plant or a normal nuclear plant, these days. But we all do recognize that our utility system load, electric energy, is going to increase in demand.

We are certainly in somewhat of a recession now, but I haven't seen any forecasts that indicate there isn't a need for additional electric generating capacity, and there is also the need to replace obsolete units, to get off oil; so there is the need out there.

We are caught in kind of a catch 22 in that we do need some help with this lead plant project, and it is difficult to get a lot of enthusiasm from utilities when the administration won't step in and do a little bit. So, it is a kind of chicken-and-egg sort of thing. But we, certainly, stand ready to move forward. We hope that DOE will see the merits of which we have enumerated many times on this project type of concept, and the need is certainly there, and we do plan to continue our efforts. If you won't give us any support at all, the administration won't, then it is going to be difficult for us to get utilities to support it.

I hope that is responsive to your question, Mr. Lowery.

Dr. Agnew.

Dr. **Agnew**. I might add to that, I did sit in for a moment yesterday and heard Mr. Dillon's testimony. What he did not say was that in their original budget submitted to OMB they had fully funded this program, and they recalled it—in the OMB there is a particular antinuclear segment. At the same time it is very interesting, Madam Chairman, that there is a budget amendment, a 1982 amendment, that part of DOE is coming in with for something around $2 million-plus to study a particular reactor which they are interested in—the replacement production reactor which Mr. Walker referred to—which was considered for the Idaho installation. And I am told that in the 1983 submittal they are coming in with something around $20 million.

So, the two sides of the House either are not coordinating, or something strange is going on, but they—not only do the utilities need this type of technology in their future, but I believe the Department of Energy or the Department of Defense, whichever prevails eventually on the nuclear program also has a dire need for this technology for all the reasons that Mr. Walker mentioned: The efficiency and the ability to make whatever materials they may require, not only for the defense programs but also for fusion. You people are very much involved in supporting fusion, you have half a billion a year, essentially, and there is no way the fusion program can get off the ground in this country unless they have available supplies of tridium.

Mr. **Lowery**. Mr. Richards, do you care to comment?

Mr. **Richards**. I think the points have been well covered on that question.

Mr. **Lowery**. I am in agreement with the panel.

Let me follow up. It just strikes me that neither DOE nor OMB, are applying the same criteria across the board on other projects, Clinch River for instance, a project which I have been very supportive of. It has similar problems in terms of the acquisition of funding that they used as an excuse, let's say in the case of HGTR, but they are not applying it in that case. Do you see any similar parallels or differences? And I am aware that HGTR had the support of the Department of Energy up until the budget went to OMB.

Dr. **Agnew**. I suspect the answer to your latter question is just that there are greater forces than the antinuclear group in the OMB with regard to Clinch River, because as we mentioned in the——

Mrs. **Bouquard**. I think I will agree with Dr. Agnew.

Mr. **Agnew** [continuing]. In the meeting that we had recently in Chattanooga, it was pointed out that without breeding then uranium and thorium don't represent 90 percent of our total potential energy. We are going to need it some day, we need that technology, we need to develop that technology and have it in hand.

Mr. **Lowery**. Will the necessary technological and institutional development requirements be designed before we can really have a commitment for a lead project?

Mr. **Walker**. Yes; by June of this year as part of the fiscal 1982 work plan, we will have a lead project decision package completed which is what we have been working on. This package will have design and cost report, the design and technology development plan, and the licensing plan. So, that will occur in mid summer, hopefully there will be an 1983 budget approved by that time so that we will know there is funding to go ahead. And then we will continue to work with these five groups of utilities that I mentioned to try to get further commitments from them so that we can proceed into the next phase which would be the preliminary design and licensing phase, which would lead to a preliminary safety analysis report.

But all these things kind of have to go together. There has to be the continuation of the funding and it kind of all has to go, but we think we are on schedule and if this budget is restored that we can continue on the plan that is laid out in our strategy.

Dr. **Agnew**. Let me mention the main technical work which remains to be done. One is changing the design from the Fort St. Vrain to meet all present seismic requirements that require changing in the structural layout of the plant, and in particular we have gone from steam driven circulators to electric drive circulators, and that work and endeavor is being done—contemplating being done—at General Electric, not Mr. Richards' organization, but their electric motor development division. These are big motors and bearings, and that technical work has to be done. Otherwise we are in pretty good shape.

Mr. **Walker**. I might add, Congressman, that these changes that have come about as to size and the type of drive and doing away with reheat were made, really, by the utility group, and our advice as to what, after operating St. Vrain, we saw as ways to make this concept more reliable, and so these changes really have been made by the people that are going to use this type of equipment, which is the way it really should be.

Mr. **Lowery**. One final question.

Mr. Walker, I am sure you are aware the DOE authorization report by the Science and Technology Committee last year had language that said, "Before the fiscal year 1983 budget is acted upon, the committee should be provided by utility representatives with letters of intent to purchase HGTR lead plant."

Do you see your letter of March 16 to Chairman Fuqua as meeting that language intent?

Mr. **Walker**. I think in a general way I guess it gets down to semantics on how you define a letter of intent. A letter of intent generally is to a manufacturer to actually purchase something provided certain conditions are fulfilled. This letter wasn't written to a potential vendor. It was written to show that we do have viable lead utility candidates. Obviously though, in addition to a user, you have the vendor and a manufacturer. We have laid out the lead utility candidate and the logical situations that might turn out to be lead project. And I feel fortunate that we do have a diversity to go from. I feel much more comfortable than just having one group that might be proceeding, and as I indicated a little earlier the climate for ordering any kind of a powerplant today, with the interest rates—and you are all aware of that—makes it difficult to get a firm letter of commitment out of anybody in today's economic situation. But I have hope that this will turn around and we will all be able to continue to carry on business as normal and make the normal kinds of commitments.

Mr. **Lowery**. You see this as a phased intent for a HGTR lead plant?

Mr. **Walker**. I think that, maybe, that is a good word, Congressman.

Mr. **Lowery**. Madam Chairman, if you could indulge me with one more question, not on the subject of HGTR, but directed to Dr. Agnew.

We received a response on those written questions submitted to DOE regarding Doublet III. We are aware that the pace of the fabrication of the new vessel for the Doublet III experiment depends on a couple of things: First, the adequacy of funding for the fusion budget, and, second, the willingness of the Japanese to contribute funds directly toward its construction. And it appears that the Department has given sufficient support to Doublet III expansion, but I am a little concerned with, or at least would like some amplification on the present United States-Japan agreement that will expire in August of 1984, and how that impacts the project. Of course, it will be dependent upon renegotiation and an extension of that agreement. DOE told us that they were hopeful to have an extension agreed upon by the fall of 1982. And from your perspective, Harold, what can you tell us in regard to the progress that DOE has made concerning the extension, and what is the present attitude of the Japanese regarding their cooperation with the United States in development of fusion energy?

Dr. **Agnew**. The head of our work, Dr. Okawa, just came back from Japan. I will be going over for the United States-Japanese agency steering committee which will take place the week of May 10. The information that Dr. Okawa came back with is the Japanese are still enthusiastic about continuing the work and they see the wisdom of incorporating what is known now as the Big D into the machine. As you are aware, the total cost for the project is $35 million, and when you consider the information which that will make available on a timely basis and the impact that could have on our own program as well as the Japanese program—the Japanese being very prudent people—I would have no doubt that they will join it. Their problem is, right now, their budget cycle doesn't work in with our budget cycle, and so we have to wait until they have made their presentations to the Diet—it is just not in phase with ours. But I have no question that the effort they have put in and with the results which they have obtained, and with their team in San Diego very enthusiastic, and having this Big D could save them and ourselves from serious embarrassment of going to a much larger machine without going through this intermediate step.

So I have no questions in my mind, especially since the total price is only $35 million over 3 years. And that includes operating as well as the fabrication costs. I have no qualms that they will come forth. If they don't, they may be very sorry.

Mr. **Lowery**. Is it a well-designed and versatile machine that you all have put together?

Dr. **Agnew**. Absolutely.

Mr. **Lowery**. When can we expect to see Japanese funding?

Dr. **Agnew**. I don't know what the time line is. I do know that we will be meeting, as I said, the week of May 10, and I would expect that we will have some information then, and we will certainly let you and the committee share this with us.

Mr. LOWERY. Thank you, Dr. Agnew.

Thank you, Madam Chairman.

Mrs. BOUQUARD. Thank you very much, Mr. Lowery.

I want to apologize to the panel for leaving. We have representatives of the Oak Ridge National Laboratory in another committee that I certainly wanted to welcome to Washington today.

Mr. Walker, it has come to my attention that the operating temperature of the lead plant project is lower than that of the Fort St. Vrain, which is a 380-megawatt plant operating in Colorado. Would you comment on this decision?

Mr. WALKER. Yes; the 2,240-megawatt thermal plant, as I recall, has a helium outlet temperature of sightly under 1,300°, 1,280°. Our plant was designed at a higher temperature, about 100° higher than that. Our plant also has what is called reheat in it. In other words, you use the steam, take part of the energy out, send it back to the reactor, and reheat it.

As I indicated earlier, after the utilities looked at the operation of St. Vrain and looking for ways to simplify and make the system more reliable, we did away with reheat, did the whole thermodynamic balance of the proper temperature on an economic basis, and it turned out that the simplification, even though the temperature being a little lower hurts efficiency, that on balance it was a more economic thing to do. And lowering the temperature, of course, gives you some increase margins of safety also. Even though it wasn't a unanimous opinion on exactly how we should do that, it was a consensus of those utilities involved that that was the proper temperature to end up with. And I might add, Madam Chairman, that was done in many areas—the one on size and some of the other parameters of the plant were decided by our committees of utilities who will be the ultimate users.

Mrs. BOUQUARD. Will this enhance the reliability of the plant components?

Mr. WALKER. Yes; absolutely, we think it will.

Mrs. BOUQUARD. After the program progresses, and after we do hopefully see significant private investments made, what are the plans on managing the lead plant project?

Mr. WALKER. The normal way we would like to see it go, of course, is the user, the utility would be the manager of the project. I think that's in the best interest of all of us to have a key individual in the user/utility. If it should happen to be a joint plant you would pick one utility to be the actual project manager/builder of it, and they would appoint a key person to be the leader, and so we would look for it to be utility controlled because 75 percent of the money going into the facility would be from the private or the utility sector.

Mrs. BOUQUARD. Can your proposed project schedule be shortened?

Mr. WALKER. I think it would be very difficult. We have got it about optimal now. Even pouring a great deal more money in because of the time to do the PSAR, the time to do the licensing, unless there is some remarkable changes there, which I don't see, and then the actual construction period, I don't really think it could be shortened much. On the other side of that coin, of course, if we don't get funding and we are delayed a year, why that would stretch it out. But there is a little bit of slack in the 1995 date but not a lot as we see the situation today.

Mrs. BOUQUARD. What kind of financial support are we really talking about from the Government and the timeframe for the specific purposes?

Mr. WALKER. As I indicated a little earlier, the Government money would be used in for the front-end design and technology development, there would be money for fuel cycle development, then some money for first-of-a-kind equipment costs would make up the 25 percent of the total lead project cost that would be asking the Government to fund.

Mrs. BOUQUARD. How about loan guarantees or similar support?

Mr. WALKER. That would always be a possibility. Those are the kind of arrangements that could be considered, and they have been in some other activities. I guess that depends upon the economic climate, and what your other sources of funding might be. Obviously, if it costs you 17 or 18 percent to issue long-term bonds you might be looking for an alternative to do that. I hope, maybe that situation will not be with us forever.

Mrs. BOUQUARD. We all hope that situation will not be with us for long.

Mr. WALKER. And so given reasonable financial situations you would hope you could do it in a straightforward way. But it might be that some sort of guarantees might be in the books, but we haven't really made that decision until we pick the actual lead plant candidate, and those arrangements would——

Mrs. BOUQUARD. Has someone actually signed a contract with you? Do you have any candidates other than the five that you have mentioned?

Mr. WALKER. These are the five that we have identified. I am sure there may be other utility interests, but as I indicated earlier, unless we can keep the program going and unless the whole climate for nuclear energy improves it is not the easiest thing in the world to attract new people into your group.

Mrs. BOUQUARD. When there is a lack of commitment and continuity by the Federal Government to a program it seems that we cannot attract the attention of the private sector or of our allies as well in developing a sound energy policy.

Mr. WALKER. That is absolutely right, Madam Chairman.

Dr. AGNEW. I might add, if you look at the totality of the Japanese and the German programs, their level this year is 10 times ours. In fact, their annual input this year is almost the total amount that we require. We are talking around $350–$400 million total from the Government, and that is the annual budget in Germany and Japan.

Mrs. BOUQUARD. In 1 year they are doing what you are asking us to do over a reasonable time?

Dr. AGNEW. I am afraid that it is clear that France is taking the lead in the water systems. I am convinced that the American industry, if we develop HTGR technology, we can regain nuclear leadership and that will mean a lot in exports, a lot of jobs, and we will be the forerunners again. And if we don't, then it will be the Japanese import auto machines all over again.

Mrs. **Bouquard**. This is really about the only technology left where we still have a chance to take the lead at the present time.

Dr. **Agnew**. I think so. Regain is perhaps a better word.

Mrs. **Bouquard**. I think that is a better word, Dr. Agnew.

I think you perhaps answered this awhile ago as I was coming in: Does any research remain to be done on the HGTR fuel cycle to support the lead plant project?

Dr. **Agnew**. As I mentioned, the work is being done in conjunction with Oak Ridge and ourselves, and it is really in completing the cycle. We have processed cold all of the fuels. We have even processed the German fuel. What needs to be done eventually is to process hot fuel. But the present plan, of course, is not to do any reprocessing until there is a real backlog of the fuel. The spent fuel in this instance can be stored, some of it is being stored. Mr. Walker's fuel is being stored in Idaho. It is being stored dry. The people that handle these materials say it is beautiful, they wished all fuel that they handle was as easy to handle. But eventully one would, when the economics dictate, reprocess this fuel.

Mrs. **Bouquard**. Will the lead plant be a standardized design suitable for various installations?

Dr. **Agnew**. I would hope so. What we really have is the option for three plants. The lead plant is, as Mr. Walker mentioned, and I will use the term "electrical," an 880-megawatt electrical. We have the option later on, using standardized components—it is a modular design—of going up to 1,320 or going down to 440. The 440 would be a two-loop plant, the lead plant is visualized as a four-loop plant and one could go to a six-loop plant. So we have those particular options. And that they will absolutely be standardized in all the major components because it is modular in the sense of the number of loops. I would not recommend going to one loop because I think you need the redundancy just for safety reasons.

Mrs. **Bouquard**. Would you say the current lead plant project is really best suited for the utility companies, while the smaller modular gas-cooled reactor that you mentioned might better meet industrial needs?

Dr. **Agnew**. Well, it depends. We are engaged in a study in the Port Arthur area where there is a need for cogeneration—if you have a need for electricity and process heat then I believe the two-loop plant could very well fulfill that need. If you have a need only for process heat, then I think the particular system that Mr. Richards referred to would be appropriate. But the more I see of industrial complexes, the need is for cogeneration, the need is for process heat and electricity. So I think our plant, at the temperatures we are advocating, could fulfill this need of both generating electricity and providing process heat.

Mrs. **Bouquard**. Dr. Agnew, how does the gas reactor operate on less water than other reactors?

Dr. **Agnew**. Well, as Mr. Walker alluded to, it operates at a higher temperature than the water reactors. The present-day light water reactors operate at around, let's say at around 500°. These operate at almost twice that temperature.

Now, the efficiency of a plant is determined by the initial temperature of whatever the working medium is and the final temperature. Starting at a higher initial temperature we obtain much higher efficiencies, almost 25 to 30 percent higher efficiencies than the water reactors, when we exit at the same temperature which they do. Now, if we use less water, or even use dry cooling, then we would have our waste heat exiting at a higher temperature. We would take a penalty in efficiency, but we could do that whereas you cannot do that in the water reactors. And that's why these particular systems are much easier to site. You can site them in Florida as one of the potential sites where there is a lack of water. In the West, in the arid regions. It is the only reactor, for instance, you could put in New Mexico in my opinion, because it really needs very little water. You can actually use it in completely dry cooling.

Mrs. **BOUQUARD**. Thank you very much.

Mr. Richards, what is the proposed power output for modular gas-cooled reactors?

Mr. **RICHARDS**. We are studying now about 250 megawatts thermal.

Mrs. **BOUQUARD**. These could be built and shipped to the site?

Mr. **RICHARDS**. That is a size that would fit the requirements pretty well of being able to build the components, assemble them in a factory, and ship them.

As I said before, these would be contemplated, and again this would depend on the user requirements for the amount of process steam required. They could be used in multiples. This would depend on the site requirements for them.

Mrs. **BOUQUARD**. Should this concept, which is different from the lead plant, be developed in parallel with the lead plant?

Mr. **RICHARDS**. Well, we are not far enough along yet, really, to say. The intent right now in the program for now and the next year would be to get a better idea of its feasibility, its cost, any problems that may be arising through the nature of the design. So I cannot say now it is a candidate for a lead plant. We believe some reasonable level of effort in the program ought to be devoted to it so we can establish this feasibility.

Mrs. **BOUQUARD**. What do you think would be required to obtain a commitment from NRC to proceed with the lead plant project? Do you think that a standardized design review could be initiated?

Mr. **RICHARDS**. Well, yes.

Mr. Walker might able to do better with that one.

Mr. **WALKER**. Certainly the NRC has some continuing work on the gas-cooled, but obviously there are two things required. You need—I think the NRC would need to perceive that the administration was supporting the concept before they would give it any kind of priority. The other would be the actual filing of an application with the NRC, and I can say this from experience of working with them on our plant that when you have a real problem—it is not that we haven't some delays—but they do have a cadre of people that have some knowledge of the gas-cooled systems and have worked very well with us. But certainly they have their priorities, and to make this a No. 1 priority they would have to see that both from the user and from the administration, I believe.

Mrs. **Bouquard**. So, first of all, a commitment from the administration would be required before any NRC proceedings would begin?

Mr. **Walker**. Yes, this all goes together. We need the Government support, you need the user/utility and the perception that you really have something going here for the NRC to give it any high priority, I would guess.

Mrs. **Bouquard**. I want to thank you gentlemen for your very excellent testimony and for your support.

Mr. Volkmer.

Mr. **Volkmer**. I would just like to ask, I think it becomes clear—you correct me if my statement is wrong—that if we don't have any funds for the HGTR as the budget now proposes, it is going to be delayed. If there is none in 1984 or 1985 what are your visions for HGTR?

Mr. **Walker**. We are probably out of business, Congressman.

Mr. **Volkmer**. We have still got Fort St. Vrain, and you still are going to be doing tests there; are you not?

Mr. **Walker**. Yes; we would continue to run St. Vrain. Of course, if there was not support or no program going on I don't know that it would make a lot of sense to use that reactor, which is a commercial reactor, for a lot of testing if it would be of no avail. And so I think we would continue to run it, do the best we could without any supporting technology. I think it would be a shame to see this whole industry not supported at all.

Mr. **Volkmer**. As I understand it, you are asking for $45 million and $3 million; right?

Mr. **Walker**. Yes; the total of the three parts.

Mr. **Volkmer**. And what would you need, then, in 1984? Do you have any ideas?

Mr. **Walker**. Dan Mears is our general manager. Dan, do you have the figure for 1984? It slips my mind.

Mr. **Mears**. Our estimate we submitted to the record as part of our letter for 1984—we have a projection for $69 million.

Mr. **Volkmer**. You need $69 million in 1984?

Mr. **Mears**. Yes, sir.

Mr. **Volkmer**. Where would that take us, those two funds?

Mr. **Mears**. The projection at that time is that we would be into the preparation of a preliminary safety analysis report as part of the submittal to NRC and that would be a very intense effort on getting a preliminary design conducted. Utilities would be involved in a much higher level with site review activities underway to have the PSAR submitted in 1985.

Mr. **Volkmer**. Then the only last question I have, Mr. Walker, is do you envision if that was done and those funds were provided that we would be able to, hopefully, have some contracts at that time with other utilities?

Mr. **Walker**. I think with that kind of support it would certainly make it easier to do, assuming that some of these other problems facing our industry get straightened around—that we could actually build any kind of a plant. I am sure they will. This has just been a tough couple of years to get any kind of plant started, but with that caveat I think there is a good chance that we could go forward.

Mr. VOLKMER. Thank you, Madam Chairman.

Mrs. BOUQUARD. Thank you, Mr. Volkmer, and thank you gentlemen again for your very excellent testimony and the information that you provided this subcommittee. We are very grateful for your being with us today.

Mr. WALKER. Thank you, Madam Chairman.

Mrs. BOUQUARD. Thank you.

Our next witness is Warren P. Chernock. He is vice president of development, Nuclear Power Systems, Combustion Engineering.

Mr. Chernock, we certainly appreciate you being with us today. I believe we have your prepared testimony, or if you have testimony for the record you may summarize it and proceed as you wish.

STATEMENT OF WARREN P. CHERNOCK, VICE PRESIDENT OF DEVELOPMENT, NUCLEAR POWER SYSTEMS, COMBUSTION ENGINEERING, INC.

Mr. CHERNOCK. Madam Chairman, members of the committee, I will address myself primarily to the three questions raised in Madam Chairman's letter. The testimony itself has additional details supporting the positions taken with respect to these three questions.

The first question addresses the Nuclear Safety Research Development and Demonstration Act of 1980 and raises the question as to whether $1 million in fiscal year 1983 is adequate to support that program.

My comment is that the program, as I have reviewed what is available to me for review at the present time, is inadequately detailed to provide a meaningful comment on the adequacy of funds as stated. However, I do wish to point out that there was a factfinding team from DOE that visited a large number of reactor vendors, utilities, and architect engineers, and a report was prepared in July 1981 by Mr. Giesing of DOE which contains a consensus of opinions of the utility industry representatives interviewed. This report does contain significant detail with respect to programs which could be pursued, and, at this particular time, I find it unusual that we are still going through a process of trying to define what should be done approximately 1½ years after the passage of the act.

The second question addresses whether proceeding with one vendor in the extended fuel burnup subprogram provides an unfair competitive advantage to that vendor. Again, the testimony clearly indicates that I do believe that this is the case, and, in fact, if I could quote for the record an item from page 9 of that factfinding team report.

Mrs. BOUQUARD. Without objection, it will be made a part of the record.

Mr. CHERNOCK [reading]:

> Another important facet of the joint Department of Energy/Nuclear Steam Supply System Vendors/Utilities programs is that they preclude any one organization from developing a monopolistic position in the marketplace, a concern expressed by the utilities with regard to reload cores.

You will find that my testimony supports that contention.

With respect to the question of whether vendor contributions be required in the expended fuel burnup subprogram so that it can be extended to two or more vendors, my comment is that the DOE, in negotiating these contracts, was very adroit in requiring vendors—and I can't speak for all vendors but I can speak for Combustion Engineering—extremely adroit in requiring; as headend contributions to the program, technology that had already been developed by Combustion Engineering. This technology has already been contributed to the program, has already been made public, and is valued by us in terms of millions of dollars. We find, at this particular time, that it is somewhat unusual to face a condition where we might be asked for financial contributions to continue a program which we initiated on good faith and with the understanding, or implicit understanding, that our headend contributions would provide the basis for program continuation and completion.

And, finally, I would like to quote the chairman with respect to her comment on the HGTR program, in which she just indicated that we would be regaining our technology leadership.

In the high burnup fuel program we have a technology leadership, and if that program is reduced, either to a one-vendor program or reduced in scope, that technology leadership which we now maintain throughout the world, and is well recognized throughout the world, will in fact be reduced and eliminated.

That's the extent of my oral comment, and I am open to any and all questions with respect to my written testimony.

So that I think a focused safety research effort is what is needed at this particlar time, and I would urge that DOE devote some attention to its own factfinding team report.

[The biographical sketch and prepared statement of Mr. Chernock follows:]

BIOGRAPHICAL SKETCH

WARREN P. CHERNOCK

Warren P. Chernock has been with C-E since 1956, as Manager of Metallurgy, Director of the Nuclear Laboratories and, since 1974, as Vice President of the Development Department where he is responsible for Engineering Development and Services, Fuel Development, Materials and Chemistry Development as well as Product Engineering and Development which is the C-E nuclear R&D program. He has served in various positions in industry and education. He has been associated with the Argonne National Laboratory and Massachusetts Institute of Technology as well as the Hartford Graduate Center of Rensselaer Polytechnic Institute where he is now also serving as Chairman of the Metallurgy Department. He earned a B.S. degree in metallurgical engineering from Columbia University in 1949 and a M.S. degree in metallurgy from New York University in 1955. He is a member of the American Society for Testing and Materials, a Fellow of the American Nuclear Society and the American Society for Metals and a member of the Technical Advisory Committee of the Metal Properties Council (MPC) and Chairman of the MPC Subcommittee on "Nuclear Materials". In addition, he serves on the Advisory Committee to the Department of Metallurgy and Materials Science, University of Pennsylvania; the Advisory Committee to the Department of Nuclear Engineering, Rensselaer Polytechnic Institute and the Argonne Universities Association Review Committee for the Reactor Analysis and Safety Division. Mr. Chernock holds several patents on fuel elements and has authored numerous papers in the area of nuclear materials.

TESTIMONY TO THE SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION OF THE U.S. HOUSE OF REPRESENTATIVES COMMITTEE ON SCIENCE AND TECHNOLOGY

by Warren P. Chernock
Combustion Engineering, Inc.
on March 17, 1982

My name is Warren Chernock. I am Vice President of Development, Nuclear Power Systems, Combustion Engineering, Inc. I am here today to comment on the Department of Energy budget request for Light Water Reactor Systems Research and Development Programs for Fiscal Year 1983.

One of the stated overall objectives of the Light Water Reactor (LWR) Systems Program is "to support the revitalization of the nuclear option and to contribute to the resolution of nuclear industry institutional problems." The proposed level of funding for the Fiscal Year 1983 LWR programs does not appear to be consistent with the stated objective. I urge you to reconsider the funding levels for LWR programs in FY 1983 with the aim of increasing the budget authorization to permit, as a bare minimum, the continuation of programs already underway and to consider increased funding for those programs which are at a marginal funding level at this time.

I fully recognize the pressure on the Congress for budget reductions in FY 1983. However, revitalization of the LWR to retain the nuclear option is an objective of this Administration and it is within this framework that I am providing my comments on the FY 1983 budget and programs.

It is our belief that the ability to maintain the nuclear option in the United States is strongly dependent upon the resurgence of a healthy LWR industry. Many of the problems facing the industry at this time; such as long lead times, waste disposal and regulatory uncertainty, are institutional in nature. DOE should address these institutional problems. Failure to maintain a market for light water reactors will have a negative impact on the nuclear option in this country.

My testimony is presented in two sections:

I. Specific Comments on Three Issues Raised in Representative Bouquard's Letter Dated February 26, 1982.

II. Comments on Light Water Reactor Systems Programs.

I. SPECIFIC COMMENTS ON THREE ISSUES RAISED IN REPRESENTATIVE BOUQUARD'S LETTER DATED FEBRUARY 26, 1982

The three issues raised in the above referenced letter are treated individually below:

A. Is the One Million Dollar Budget in the LWR Safety Technology Subprogram Sufficient to Implement the "Nuclear Safety Research, Development and Demonstration Act of 1980?"

My detailed comments concerning the implementation to date of Public Law #96-567 will be presented later. I assume that the proposed $1M budget is aimed at continued program planning. The reason for delay in the implementation of this Public Law is not clear to me. Combustion Engineering and other members of the industry provided comments to DOE's Fact Finding Team on implementation of the Act. That Team thereafter issued its report in July, 1981 which summarized industry comments on light water reactor safety research.

On the basis of limited DOE planning to date for implementation of the Act, we are unable to comment on the proposed funding level.

We would, however, suggest that the appropriateness of the requested funding be weighed against the approximately $200M NRC budget for safety research and development to determine how a viable portion of the NRC budget can be redirected away from the narrow goals of NRC

R&D, which tend to be "confirmatory" in nature, and directed toward reducing lead times and regulatory uncertainty as well as reducing licensing conservatisms without adversely impacting the health and safety of the public. It is my opinion that funds well in excess of $1M for FY 1983 will be required for DOE to engage in a meaningful relationship with NRC to meet the objectives of the Act. Persuasion and not duplication should be the key element of such a process. However, a Program Plan and strategy must be established by DOE and accepted by NRC if such a program is to succeed.

B. Will Proceeding With One Vendor in the Extended Fuel Burnup Subprogram Provide an Unfair Competitive Advantage to That Vendor?

Yes, it is my opinion that reading reports, even if they are complete and provided on a timely basis, is a poor substitute for "hands on" experience. The "one vendor" concept will provide some degree of competitive advantage to the selected vendor because engineering and licensing support for initial large scale implementation will have been singularly subsidized by DOE for this one vendor. In addition, there are significant differences in fuel assembly designs between the NSSS suppliers so that extrapolation of data from a one vendor program to fuel designs of other vendors will be difficult, even if all of the key information is provided in the reports. The basis of the presumption that the other fuel vendors, utilities and EPRI would "carry on the balance of the previously planned program activities without Agency assistance" is not clear to me. The fuel vendor has no incentive since fewer fuel assemblies are fabricated per year. The economic benefits associated with high burnup and longer fuel cycles must be passed on by the utilities to the ratepaying public and, thus, there is no incentive for utility or EPRI funding. It is my opinion that the programs of the "closed out" vendor/utility teams will not be completed.

One further thought deserves consideration. We are aware, of course, that contracts for these programs do permit cancellation by DOE without cause. However, because of "head end" technology transfers already made by the fuel vendors, we believe DOE has an obligation to proceed in good faith with all programs. These "head end" transfers of proprietary technology have been made public on the presumption that the programs would continue to completion. A "one vendor" program would result in a substantial sacrifice of proprietary information supplied by the other vendors. Should a "one vendor" concept be adopted, it would be logical to presume that the unsuccessful vendors should be compensated for the value of the proprietary technology made public. Finally, a "one vendor" program would jeopardize the precarious vendor-utility partnerships which have been formed.

In summary, we do not concur with the "one vendor" approach because it provides a competitive edge to the successful vendor, negates an implicit obligation of DOE that the release of proprietary technology of considerable value would be in return for programmatic completion and it adversely affects utility-government relations.

C. Should Vendor Contributions Be Required in the Extended Fuel Burnup Subprogram so That It Can Be Extended to Two or More Vendors?

As stated above, "head end" technology contributions, in the form of release of proprietary information for public dissemination, were made by each of the vendors associated with the Extended Fuel Burnup Subprogram. This was a direct result of a rigorous "bargaining" position by DOE staff which required the early dissemination of such proprietary information as a basis for program participation. In addition, utility partners in these programs have invested significant effort and have accepted performance risks associated with the development programs. I cannot estimate the value of this contribution, but I feel it must be significant.

Any requirement for additional vendor or utility financial support for continuation of these programs beyond the "one vendor" concept must recognize the contributions already made by vendors and utilities.

We hesitate to support the concept of additional vendor contributions to provide a financial basis for continued involvement of more than one vendor in these programs. We have paid the "fee" demanded by DOE up front. In addition, as noted elsewhere in this testimony, the ultimate benefit of successful completion of these programs rests with the ratepayer. Thus, it is appropriate for DOE to continue support of these programs with public funds without requiring additional funding from either the fuel vendors or the utilities.

II. COMMENTS ON LIGHT WATER REACTOR SYSTEMS PROGRAMS

A. LWR Safety Technology

This subprogram identifies activities to be emphasized in the DOE program plan.

(1) 10CFR 50 Appendix K

While we strongly agree on the need to take actions to ameliorate regulatory impacts, we do not believe that efforts to relieve requirements of 10CRF 50 Appendix K should be of high priority at this time. Current and near-future fuel designs are known to be capable of accommodating the ECCS (Emergency Core Cooling System) restrictions contained in Appendix K. Furthermore, changes in Appendix K would require a new Rulemaking Hearing and would involve substartial expenditure of manpower and funds on the part of the NRC, fuel vendors and the utility industry with no benefit in terms of improved safety. In addition, with reductions in NRC budgets contemplated for FY 1983, the diversion of manpower to such a marginal activity could result in licensing delays for plants which are, or are about to become, docketed for review. Other NSSS and fuel vendors, as well as representatives of the utility industry should be contacted to determine their comments and recommendations concerning changes in Appendix K before any funds are expended for such activities.

On the other hand, the concept of utilizing Government created data to justify a relaxation in licensing conservatism is meritorious and the following three step process could be considered:

1. Identify areas in which licensing conservatisms could be reduced and for which licensing relaxation has a reasonable chance of being achieved, without adversely impacting the health and safety of the public, and which could provide tangible benefits to the ratepayer.
2. Examine, in detail, completed U.S. government programs, available results from other countries and published literature to identify programs containing appropriate data, which, if properly analyzed, would provide a basis for licensing relaxation.
3. Apply the data to remove conservatism.

It is our opinion that the following areas, among others, would prove to be fruitful for removing conservatisms:

- a. Seismic design bases (reduction of the level and/or breadth of the peak response of Regulatory Guide 1.60).
- b. Seismic design practice (obtain credit for energy absorption from the plasticity of piping runs).
- c. Pipe break criteria (aimed at relaxing the current double ended pipe break assumptions which influence the design of support structures and pipe whip restraints).
- d. Fission product release assumptions and transport assumptions (some analyses indicate that the source term assumptions are high by two to three orders of magnitude).

(2) Nuclear Safety Research, Development and Demonstration Act of 1980 (Public Law #96-567)

DOE was required to submit a report to Congress concerning recommendations for implementation of this Public Law. At the request of DOE, we have reviewed this Report and we have supplied written comments to DOE. Some of these comments are summarized below:

1. C-E supports the DOE conclusion that a National Reactor Engineering Simulator Facility (Section 5 of the Act) and a Federal Nuclear Operations Corps (Section 6 of the Act) are neither necessary, nor appropriate and we endorse the DOE recommendation against pursuit of their further consideration.
2. It is intended that results of safety related programs be used to enhance the effectiveness and speed of licensing processes. Specific DOE and NRC roles should be clearly defined and, if safety related programs are initiated, advance concurrence on their relevance should be obtained from NRC and specific implications should be identified for each of the possible potential result paths.
3. It is our belief that resolution of the major problem of long lead times can best be accomplished by:
    a. Identifying, in a limited time, the major factors which have caused an increase in construction time

from 5 years (Maine Yankee) to the current period of 10 to 12 years, or more.

b. Determining, in a realistic manner, the improvements which can now be made on the basis of a more mature industry with many reactor years of operation, and which can provide both reduced lead times and less plant complexity without compromising safety to the public. A target lead time of 6 to 7 years is possible. Identifying these improvements should be performed with expediency so that they may be implemented with little delay.

4. The Report which we reviewed does not provide sufficient detail in Section 8 (Program Management Plan for the Conduct of A Research, Development and Demonstration Program for Improving the Safety of Nuclear Powerplants) on what will be done, who will do it, who will manage the programs and how the programs will be performed. In addition, schedules and funding requirements were not included. This Report does, however, indicate that program planning will be performed in coordination with industry and NRC. Possibly this will provide the DOE/NRC link needed to lend viable acceptance by NRC of programmatic results. On the other hand, we, and other members of industry, have already provided extensive input to the DOE Fact Finding Team Report, referred to earlier, which summarized, on a consensus basis, industry comments on light water reactor safety research. We, therefore, do not understand the basis for post-

poning much of the detailed planning. We do note that Working Groups have been established and that reports containing Working Group recommendations are scheduled to be provided to DOE by April 30, 1982. These recommendations would then form the bases of DOE programmatic responses to Section 8 of Public Law #96-567. We hope to have an opportunity to review and comment on the details of the proposed DOE program before it is implemented.

On the other hand, our views concerning "Overall Program Management" might be helpful in formulating future DOE plans for implementation of this Public Law. It is our recommendation that Overall Program Management be provided at the highest possible level within DOE. We propose that consideration be given to establishing an Advisory Committee, including industry representatives, for this program. The function of this committee would be to act in an advisory capacity to DOE and this committee should be empowered to recommend, where necessary, changes, deletions or additions to the program to assure its continuing focus on the major objectives of the Law itself. (The term "industry" should be considered to include, as appropriate, Institute for Nuclear Power Operations (INPO), Atomic Industrial Forum (AIF), Industry Degraded Core Rulemaking Program (IDCOR), Electric Power Research Institute (EPRI) and individual reactor vendors and utilities).

(3) The Conduct of Selected R and D Efforts to Provide a Basis for Better Compatibility Between Regulatory and Plant Operations Requirements

DOE has conducted selected R&D efforts to assist the industry and the Government in addressing specific critical safety-related issues. Some of these include support for the Institute for Nuclear Power Operations (INPO) and past programs related to the Three Mile Island nuclear power plant. To this end, some of the work being done by INPO and the Electric Power Research Institute to help improve human performance in nuclear power plants is very timely and appropriate. DOE has supported some of this work in the past. We believed that this support would be welcome in the future because development efforts to improve operator performance should include the utility industry. Those utilities wishing to turn to the Government for support are likely to find it difficult to turn to the NRC because of the adversary relationship that exists through the licensing process.

B. LWR Extended Burnup

We concur with the objectives stated in the first paragraph on page 110 of the DOE Budget Request for FY 1983. However, as stated earlier, we do not concur with the "one vendor" concept.

I suggest we reexamine the theory underlying the Extended Burnup Program in order to put my remarks in context. Combustion Engineering, as well as other fuel suppliers, is participating in DOE sponsored programs aimed at the development and demonstration of high burnup fuel. Electric power generation costs can be reduced by lengthening the time between reactor refuelings and by increasing the lifetime of the fuel. Utilities could implement these new technologies, when available, thus reducing the cost of power to the consumer.

To understand the source of these economic benefits, it is important to realize that there are two separate improvements:

1. Increasing the time between refuelings (increasing cycle length).
2. Increasing the life of the fuel (increasing fuel burnup).

Either of these improvements can be implemented separately. However, the greatest overall benefits are obtained when long cycles are employed *in conjunction* with high burnup.

The first of these technological innovations, increasing the cycle length, results in reactors being refueled less often (in the PWR, switching from refueling once a year to once every 18-months). Reducing the frequency of refuelings is economically advantageous since more expensive replacement electricity generated from fossil fuels must be used during the period the reactor is shut down for refueling. While utilities have (or are planning) to refuel once every 18-months this is being done without the second technical improvement, increased burnup (longer-lasting fuel). This is because implementing longer cycle is technologically straightforward; it is the latter improvement which requires some development, and which is the subject of Government sponsored development and demonstration programs.

When only the improvement of longer cycles is implemented, economic benefits result solely from the improved reactor availability. While the reactor is fueled less often, more fuel is replaced at each outage and the fuel still stays in the reactor for three years, so that burnup is not increased. When only the cycle length is increased, requirements for enrichment and uranium actually increase. The resulting increase in fuel cost is smaller than the savings in replacement power, resulting in a net economic benefit for increasing cycle length.

The second improvement, longer-lasting or high burnup fuel, involves designing fuel which can last a longer period of time in the reactor. An increase in fuel burnup from the current level of about 33 MWd/Kg to 50 MWd/Kg would permit fuel operation for four or five years versus the three years which is presently typical for PWRs. This technological improvement, when implemented alone (i.e., in current 12-month cycles), would reduce the amount of uranium required by about 15%. Fueling costs are reduced because of the lower uranium requirements and because of the lower requirements for fuel manufacture and, eventually, disposal.

When both longer cycles and longer lasting fuel are employed, economic savings are realized both from reduced replacement power costs (due to the longer cycles) and from reduced fueling costs (from the longer lasting fuel). In this instance, there is a net reduction in uranium requirements of about 3%, and about a 40% reduction in the quantity of fuel to be fabricated. This reduction in fuel requirements will also result in a corresponding reduction in the quantity of spent fuel discharged after each cycle, and will ameliorate the problem of spent fuel storage at reactor sites where storage rack capacity is limited. A similar reduction would also be realized in the requirements for eventual fuel reprocessing, thereby reducing both the volume and cost of this activity.

The DOE sponsored development programs address, primarily, the demonstration of high burnup fuel. The main thrust of these programs is to provide the basic technical information required for fuel design and to demonstrate satisfactory fuel performance at high burnups.

As noted above, the reduced requirements for uranium, fuel fabrication, fuel storage/disposal, and transportation result in reduced power cost to the consumer. When annual cycles are retained, these reductions in fuel cycle requirements result in savings of approximately 6.8 million dollars per year for each thousand megawatt reactor. With 18-month cycles, savings are larger because of improved plant availability; annual savings of approximately 9 million dollars per thousand megawatt plant would be obtained using present economic assumptions. Simple multiplication of the annual savings per thousand megawatt plant times the integrated number of thousands of nuclear megawatts to be generated yearly by the year 2,000 (only 18 years away) clearly demonstrates the potential integrated cost savings to the ratepayer of many billions of dollars. In order to obtain these benefits without delay, it is essential to pursue, through completion, the DOE development and demonstration programs.

I would like to reemphasize the importance of the Government maintaining the significant advancement made in recent years in establishing relationships with utilities and reactor vendors on existing cooperative programs. These cooperative programs should be maintained, not only because of their direct relevance to research and development in light water reactor technology, but also to retain an investment in an established relationship between the Government and the utility industry which will be necessary for closing the fuel cycle and pursuing the breeder. Loss of confidence by the utilities in the ability of the Government agency to bring its contracting activities to their intended conclusion, even in light of current White House and OMB budgetary restrictions, could result in a large backward step with respect to the current positive relationships which were difficult to achieve and required years to cultivate.

Finally, let me express the opinion that, while in the past the U.S. has been viewed as a world leader in nuclear technology, this position has been challenged recently due to the constantly changing policy of previous administrations. The U.S. is clearly ahead in the area of high burnup fuel and continuation of these programs would help to reestablish U.S. world leadership in nuclear technology. Reduction or elimination of these programs will perpetuate the fears of many nations, as well as those of the utility industry, that the U.S. can no longer be counted upon for such leadership.

C. LWR Radiation Dose Reduction

Programs aimed at radiation dose reduction for individuals involved in operating and servicing nuclear power plants should be pursued with vigor. It is my understanding that the programmatic efforts previously authorized were aimed at the development and demonstration of technology to reduce occupational radiation exposures. One of the major objectives of this effort is to reduce maintenance requirements by improving component reliability. A second objective is to develop improved equipment and techniques for performing maintenance and service operations which should result in lower exposure of operating personnel. These efforts are commensurate with the objective of reducing radiation doses to the lowest level practicable.

Since these programs reduce reactor down times via improved maintenance efficiency, they result in substantial savings to the utilities which are then passed on to the ratepayers. On this basis the cost for such programs should be borne by the public sector.

It is my opinion that zero funding for new programs and close-out of existing programs in FY 1983 should be reassessed by a DOE/Utility Industry/NSSS Vendor/A-E team to determine whether such action is in the best interest of the taxpayer and to identify those programmatic efforts which, if pursued with public funds, would provide the optimum cost/benefit ratio. Those programs which are identified in the low cost/benefit ratio regime should then be ranked in order of priority and should receive consideration in the preparation of the FY 1983 budget.

Mrs. BOUQUARD. Thank you very much for being with us. I certainly appreciate your fine testimony.

Would you elaborate a little bit more on your concerns about the comparative budgets of DOE and NRC safety R. & D. programs?

Mr. CHERNOCK. Yes.

With respect to the NRC safety programs, my understanding is that they are budgeted at about $200 million a year, and that the particular aim of the program is one of confirmation: One of confirmation that certain events will in fact occur, confirmation that the very large breaks which was the subject of much of the NRC activity prior to Three Mile Island will in fact be substantiated. It is more of a substantiation of a predetermined set of conditions rather than a program aimed at mitigating certain conditions.

My comments in the testimony pertaining to appendix K is a specific example of where one would go astray, by devoting an appreciable amount of funding to an area where there is no need at the present time with respect to the industry to pursue such activites. For example, I serve as chairman of the Metal Properties Council Subcommittee on Nuclear Materials, and many years ago when ECCS was a very prominent issue we put together a team with EPRI, all of the fuel vendors, Exxon, Westinghouse, Combustion, GE, and Babcock & Wilcox, and pursued a program with EPRI support at Battelle Northwest. Oak Ridge pursued a parallel program with ERDA funding at that particular time.

The MPC/EPRI program at Battelle Northwest was aimed primarily at determining high temperature properties of zircaloy. The Oak Ridge program was primarily aimed at determining whether the energy released during oxidation of zircaloy presumed by the Baker-Just equation was, in fact, realistic. These programs have been completed. The results are sitting on a shelf. The results could be made part of a rulemaking hearing at the present time and could very well result in relaxation of appendix K. To enter into a rulemaking hearing at the present time I think would be time consuming, both from the standpoint of the vendors, the industry, and NRC, and could very well result in pulling NRC staff away from the important activity that they are now involved in with respect to the plants which are on the docket or about to be docketed.

Mrs. BOUQUARD. You mentioned the delay in the working group activities to define a reactor safety program. Do you feel that the program definition schedule could have been a bit tighter?

Mr. CHERNOCK. The program definition would have been a little bit faster, if that is what you mean by tighter. Yes.

Mrs. BOUQUARD. Do you believe that major new R. & D. initiatives are necessary to formulate a comprehensive national LWR safety program?

Mr. CHERNOCK. I believe that the initiatives are fairly enumerated in the factfinding team report. I do believe, also, that there is one other area in which DOE could participate in such activities, DOE could participate in an initiative which EPRI has initiated, and that is a new program aimed at one-step licensing. This is in its formative stages at the present time. John Taylor at EPRI is pursuing a better definition of this effort and the involvement of DOE in this particular activity I think would be welcome and would be well worthwhile.

Mrs. BOUQUARD. Thank you so very much.

Mr. Volkmer.

Mr. VOLKMER. I am just trying to listen to your testimony, and I read your statement over last night a little bit, but I may be a little confused by everything that has been said here.

Am I to believe that we need to continue further research and development on LWR safety?

Mr. CHERNOCK. That is something that needs to be done to reduce the large degree of conservatism which is now involved in many of the presumptions that are made in the licensing process. If we go back and look at the bases of some of the licensing issues you will find that they have been selected on the basis of high degree of conservatism at the time that they were first instituted. The programs that I think might be instituted at the present time are those that would relieve regulatory uncertainty and establish some degree of regulatory consistency.

So that if we look at the DOE role in something along these lines, there are six areas which are inhibiting the nuclear business at the present time. There is low load growth. This is nothing that DOE can do anything about. There is the high cost of money, which is very little that DOE can do anything about. But there is the area of long leadtimes, regulatory uncertainty, public perception, and high level waste disposal. These are areas which should be addressed and could help the industry appreciably.

Mr. VOLKMER. And the R. & D. would address those perceptions or those bases for some of these conservative attitudes that has led to some of the regulations then in the licensing procedure?

Mr. CHERNOCK. Exactly.

Mr. VOLKMER. Thank you, Madam Chairman.

Mrs. BOUQUARD. Thank you, Mr. Volkmer.

Mr. Hollenbeck.

Mr. HOLLENBECK. Thank you.

Mr. Chernock, what international participation in the extended fuel burnup program do you anticipate for fiscal year 1983.

Mr. CHERNOCK. With respect to DOE?

Mr. HOLLENBECK. Yes.

Mr. CHERNOCK. I would expect that DOE would be participating in a program which is funded by DOE via combustion engineering with KWU on ramp testing of fuel. This is a program that is aimed at relaxing the preconditioning and fuel operational parameters in achieving power after long shutdowns. This program is a very highly leveraged program and, if I recall correctly, is something in which I believe DOE is expending something on the order of $1.6 million and is leveraged to the extent that there is something on the order of 5.6 million dollars' worth of prior technology that they are obtaining. And I can—if you can give me a minute here.

There is also in addition to that, an addition of about 5.6 million dollars' worth of background technology that DOE is obtaining in this area. There is also the equivalent of about 2.2 million dollars' worth of work that will be performed in a ramp test program, ramp testing approximately 20 samples for DOE. There is also DOE involvement in a tribulation program which is a program in Belgium, again associated wth separate effect studies associated with high burnup fuel. DOE has also been involved in some ramp test programs with respect to the Swedish effort.

Mrs. **Bouquard**. Thank you very much, Mr. Hollenbeck.

Mr. Chernock, we certainly appreciate you being with us today and giving us the advantage of your very valuable insight.

Mr. **Chernock**. Thank you, Madam Chairman.

Mrs. **Bouquard**. There is no further testimony.

The subcommittee will meet again next week, Tuesday, March 23d, at 9 o'clock in this room. The subject will be magnetic fusion, and we will have Department of Energy witnesses at that time.

The subcommittee is adjourned.

[Whereupon, at 2:29 p.m., the subcommittee recessed, to reconvene Tuesday, March 23, 1982, at 9 a.m.]

FISCAL YEAR 1983 DEPARTMENT OF ENERGY BUDGET REVIEW

THURSDAY, MARCH 25, 1982

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met, pursuant to recess, at 9:05 a.m., in room 2325, Rayburn House Office Building, Hon. Marilyn L. Bouquard (chairman of the subcommittee) presiding.

Present: Representatives Bouquard, Wolpe, Lujan, and Hollenbeck.

Staff present: Ron Williams, technical consultant; and Joyce Gross Freiwald, Republican technical consultant.

Mrs. Bouquard. The subcommittee will come to order.

Good morning, ladies and gentlemen. Today we will receive testimony from Government and private witnesses on R. & D. in electric energy systems, energy storage systems and small-scale hydroelectric energy programs.

This committee has continuously and overwhelmingly supported research and development in electric energy systems. Over $46 million was appropriated for fiscal year 1981, but last year because of budget constraints, just $25.8 million was appropriated for fiscal year 1982, and only because Congress wanted it badly. Now we have been presented with a going-out-of-business budget for fiscal year 1983. One of the principal architects for these cuts is, of course, our administration.

In the case of energy storage, this committee supported appropriations of $59 million in fiscal year 1979, $66 million in fiscal year 1980, $72 million in fiscal year 1981, and $42 million in fiscal year 1982. The Department of Energy, however, wants to see this program abruptly phased down to less than $7.2 million which is 10 percent of the fiscal year 1982 level.

It has been stated that "Good progress has been made in Government-sponsored research of near-term battery systems, and so forth," but I do hope that we haven't forgotten that it was the committee chairman and I who convinced DOE not to rescind the $4 million in fiscal year 1982 that would have further disrupted the storage program.

The hypothesis that industry will jump in and fill the void if Government abandons these programs is not sustained by the committee experience.

I am sorry, Mr. Tribble, that you could not have been with us December 8 when we had five witnesses to testify that neither the utilities nor industry could finance all of the research and development work now funded by the Government in spite of the tax incentives.

The position of these witnesses was further supported by 17 separate papers from industry and utilities. Of the 23 leading organizations in the field of electric power and storage, only 1 felt that they did not need Government participation. However, even that firm stated that they would seek Government support for development after they tied up patents through proprietary results on their basic research.

One of the most supportive members of the committee in regard to electric energy programs has been Mr. Howard Wolpe of Michigan. Although Mr. Wolpe and I differed on several major energy policy questions, we are still good friends. I have always admired his diligence and his willingness to reach constructive compromises such as we achieved on the nuclear waste bill.

I do want to compliment him for his active concern about the need for distributed electric systems and storage technologies. I am now going to turn the gavel over to Mr. Wolpe who will be chairing this morning's hearings.

It is all yours, Howard, and I will be back shortly. Thank you.

Mr. **Wolpe**. Thank you, Madam Chairman. I am always glad to be involved in an issue in which we share a common viewpoint, and this is one of those occasions.

I will not add to the remarks of the chairman at this point. I will instead turn directly to our witness, Mr. Tribble.

We will be pleased, of course, to enclose your entire written testimony as part of the record. We would ask that you might summarize your written remarks.

STATEMENT OF JOSEPH J. TRIBBLE, ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY, ACCOMPANIED BY MAXINE SAVITZ, DEPUTY ASSISTANT SECRETARY FOR CONSERVATION, DEPARTMENT OF ENERGY

Mr. **Tribble**. Fine. Thank you, Mr. Chairman. I would appreciate it if you would do that. I would like to introduce Maxine Savitz, who is the Deputy Assistant Secretary for Conservation with me. She is the expert in many of these fields, and I am sure I will be calling on her to answer some questions.

Following the oil embargo of 1973 and until 1980, the United States faced a problem that was quite different from those that we had faced in the past. Some thought that our sources of energy were being exhausted. We were becoming more and more dependent upon oil imported from the Middle East. While prices charged for this oil were escalating rapidly, most of the prices for domestically produced oil and natural gas were controlled at very low levels. Relatively inexpensive energy, one of the building blocks of our economy, was becoming a thing of the past.

Many people felt that this was a problem that the Federal Government could and should resolve. There were vocal demands for attempts to do so. In response, Congress enacted a legislative program which was designed to force energy conservation and subsidize rapid development of energy from renewable resources. Since the enactment of this legislation, billions of dollars have been spent on research, development, demonstration, and commercialization activities for the purpose of bringing into more widespread use energy from such sources as solar, geothermal, wind, biomass, ocean thermal, hydropower, and alcohol fuels. The technology for using these sources of energy has been advanced to the point where further development and use can now be implemented by the private sector whenever they become economical.

Today the energy situation does not appear to be as intractable as it appeared when those legislative programs were enacted. Importation of petroleum into the United States is down more than 50 percent from its previous high. The price of domestically produced petroleum has been decontrolled, and the price of domestically produced natural gas has been permitted to rise manyfold over the price at which it was controlled in 1972. Comparing 1972 to 1980, the energy efficiency of the 10 most energy-intensive industries in the United States has improved by 17.6 percent. Comparing 1975 to 1981, the miles per gallon of fuel for new domestically produced automobiles has improved by more than 60 percent. Residential energy consumption per household is down almost 20 percent in 1980 as compared to 1972. In every case the cost of energy has been responsible for the great majority of this improvement.

It is, therefore, entirely appropriate that the role of the Federal Government with respect to energy be reevaluated. Considering that every dollar we spend is a dollar that we must borrow at current high interest rates and add to the Federal deficit, the entire proposed budget for conservation and renewable energy is very lean.

We have redirected the budget categories away from end-use products, demonstrations, and commercialization to more basic generic research.

In the small hydro category, we feel that this is a mature technology. It can be, and is being, used by the private sector whenever it is economical to do so. We have therefore requested no funds in 1983 for small hydro.

With respect to the electric energy systems program, we carefully reviewed every proposed project, and we decided either that they were no longer appropriate for Federal support or they were not of a high enough priority to borrow money for.

Consequently, we have requested no funds for this program in 1983.

We have proposed to continue work in the electrochemical field, and we have requested $7.2 million for this work.

Mr. Chairman, this concludes my statement. We will be pleased to respond to your questions and to those of other members of the subcommittee.

[The prepared statement of Mr. Tribble follows:]

STATEMENT OF

JOSEPH J. TRIBBLE

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY

U. S. DEPARTMENT OF ENERGY

Ms. Chairperson and Members of the Subcommittee:

I appreciate the opportunity to appear before you today to discuss the authorizations for the Department's conservation and renewable programs. The budget before you today reflects this Administration's commitment to the goals of the Economic Recovery Program, the need to minimize Government intervention in the marketplace, and the need to continue Federal support for research in areas where such support is appropriate.

Following the oil embargo of 1973, and until 1980, the notion was widespread that the United States faced a problem which was quite different from those we had faced in the past. Some thought that our sources of energy were being exhausted. We were becoming more and more dependent upon oil imported from the Middle East. While prices charged for this oil were escalating rapidly, most of the prices for domestically produced oil and natural gas were controlled at very low levels. Relatively inexpensive energy, one of the basic building blocks of our economy, was becoming a thing of past.

Many people felt that this was a problem that the Federal Government could and should resolve, and there were vocal demands for attempts to do so. In response, Congress enacted a legislative program which was designed to force energy conservation and subsidize rapid development of energy from renewable sources. Since the enactment of this legislation, billions of dollars have been spent on research, development, demonstration, and commercialization activities for the purpose of bringing into more widespread use energy from such sources as solar, geothermal, wind, biomass, ocean thermal and alcohol fuels. The technology for using these sources of energy has been advanced to the point where their further development and use can now be impemented by the private sector whenever they become economical.

Today the energy situation does not appear as intractable as it appeared when these legislative programs were enacted. Importation of petroleum into the United States is down approximately 50 percent from its previous high. The price of domestically produced petroleum was then decontrolled and the price of domestically produced natural gas has been permitted to rise many fold over the price at which it was controlled in 1972. Comparing 1972 to 1980, the energy efficiency of the ten most energy-intensive industries in the United States has improved by 17.6 percent. Comparing 1975 to 1981, the miles per gallon of fuel for new domestically-produced automobiles has improved by more than 60 percent. Residential energy consumption per household is down almost 20 percent in 1980 compared to 1972. In every case, the cost of energy has been responsible for the great majority of the improvement.

More remarkably, very little of this very great change in circumstance was predicted by those who urged creation of massive Federal Energy Programs. In retrospect, we see that the total effect of all government action has been relatively minor. It is, therefore, entirely appropriate that the role of the Federal Government with respect to energy be re-evaluated.

Rather than continued emphasis on bringing renewable sources of energy into the marketplace through Federal Government subsidy, it is now more appropriate that the Federal program be limited to research of a more basic nature. If some of the remaining unknowns can be removed through research, the private sector will be able to hasten the day when energy from renewable sources will take a more prominent place in our economy.

Let me turn now to the specifics of the FY 1983 budget.

Energy Storage Program

Electrochemical Energy Storage

The Electrochemical Energy Storage or "battery" program serves two stationary market sectors--the electric utility sector and alternative solar electric energy supply sources--in addition to the electric vehicle market.

Utility research is primarily funded through the Electric Power Research Institute (EPRI) to support the development of batteries suitable for utility application, and EPRI currently provides significant R&D funding in this area. Moreover, EPRI and the utilities are able to establish specific requirements for battery performance versus market potential, and the utilities have the capability to make purchase commitments that should provide adequate incentive for volume production tooling by battery manufacturers. These factors argue against a long-term role for DOE support of this market sector other than for fundamental applied research. On the other hand, the technological uncertainties associated with all the battery candidates remain significant and whether any of them under deveopment will eventually succeed is unknown. Our FY 1983 efforts will focus on only those batteries and electrochemical systems that can serve multiple applications, including the utility sector.

The stand-alone solar electric market is not expected to have a significant energy impact; moreover, this market can be served reasonably well by existing batteries or by those under development for other applications. Consequently, there is no need for a continuing DOE role directed specifically to this area.

While the electric vehicle sector may be somewhat different, the major technical barrier to the introduction of an electric vehicle fleet has been the development of low-cost, high-performance batteries. Good progress has been made in Government-sponsored research of near-term battery systems, such as improved lead-acid and nickel-iron, which should be capable of doubling the range of today's 40-mile electric vehicle. It is our intention to turn this activity over completely to industry after FY 1982. Unfortunately, the limited performance of these batteries restricts their application to the small van market or to automobiles with such short range that one cannot confidently project a significant sales level or a consequent oil saving. More generic, long-range improvements in the new classes of advanced batteries are still required if significant oil savings are to be obtained from electric vehicles. During FY 1982 the government will play a major role in sponsoring research into more fundamental work: improving the kinetics of the lithium-metal sulfide system, increasing the life of the sodium/sulfur system with the development of ionically conductive corrosion coatings, and improving the overall efficiency of the aluminum-air system through catalysis research. The successful development of the lithium-metal-sulfide and sodium-sulfur systems will produce a vehicle battery with three to four times the range of today's vehicles, while the successful development of the aluminum-air system will result in an electric vehicle having comparable performance with today's internal combustion engine vehicle. The Government role should be one of assisting in the support of the more fundamental processes relating to advanced electrochemical couples. At the present time, the battery industry, which is both depressed and inherently conservative, would not go it alone in this development because of the high technical risk and the long time before financial payback. Here, too, our generic research base in FY 1983 will support development, by industry, of batteries for electric vehicles.

DOE now supplies electrochemistry development work specifically directed toward improving the energy efficiency of industrial processes. This work generally parallels developments concurrently being supported by large sophisticated industries that are capable of increased in-house or contract support of R&D if they deem it economically desirable. There seems to be no need for a continuing DOE role, and therefore only generic technology base work will continue in FY 1983.

To back up private sector development work and to explore for and examine new ideas, DOE plans to support only generic technology base electrochemical research in FY 1983. This is an important role that can have high eventual payoff, and we are now examining the appropriate scope and focus of that work in light of the evolving battery exploration priorities. Funds for this work appear in the Energy Conservation Research budget under the Multi-Sector line item. Of the $7.22 million in the Electrochemical Storage and Conversion program, $2.185 million will be for research on kinetics, electrocatalysis,and thermodyamics.

There have been significant achievements in this area. Technology has been proven to achieve an energy density of 90 Wh/kg in lithium-mental-sulfide battery modules for possible use in electric vehicles. Our research has developed a 10-kWh zinc/bromine battery module that shows promise for solar applications; it exhibited no loss in capacity (60 Wh/kg) after 160 cycles.

Physical and Chemical Storage Program

A major portion of the DOE storage technology work has been in support of several concepts for large-scale electric utility energy storage. As described above in the electrochemistry discussion, the utilities (and EPRI) are qualified and in the best position to work with manufacturers to bring alternative large-scale storage concepts to demonstration and commercialization. Thus, DOE is discontinuing work in FY 1983 in those areas.

Thermal and chemical storage for residential and industrial users has good potential for energy savings. This market is closely allied with others served by industrial manufacturers, and the barriers to commercialization by the existing manufacturers are low. However, the feasibility of these products from both a technical and cost standpoint depends upon the performance of the materials used in the device manufactured. It should be industry's role to develop improved materials for this application; as a result, no funds are requested in FY 1983.

Seasonal aquifer storage involves low technology hardware, but assurance of economic feasibility depends upon improved understandng and modeling of heat flow in underground geologic structures. A continuing role for the DOE to develop data and analytical models that serve as a generic technology base for industry will reach a logical conclusion in FY 1982, so that no funds are required in FY 1983.

FY 1982 accomplishments in the Physical and Chemical Energy Storage Programs have been meaningful. After assembly of all parts of the 30 MJ (10 kWh) superconducting magnetic energy storage device, it will be shipped to Bonneville Power Administration for use in damping out harmful oscillations in long-distance power lines. We have also successfully tested proof-of-concept for nitrate-nitrite salts for thermal storage with solar central receivers.

Electric Energy Systems

The points I made with reference to the Energy Storage Program are equally applicable for Electric Energy Systems (EES) Program. The greater Federal presence advocated by previous administrations is not a desirable goal. It is our belief that utilities, EPRI, utility equipment manufacturers, and universities will build, over time, on the work formerly sponsored by EES. The cost-sharing contracts that we have had with industry will have been seed money. EPRI and the private sector will now have to choose what work to continue.

It is our belief that the public interests have been well served in FY 1982 by allowing only the highest priority research projects to continue. All research will be brought to a meaningful conclusion this fiscal year, and no funds are being requested in FY 1983.

Work on developing new technologies to integrate solar power (wind, photovoltaics, and so forth) into the utility grid is no longer a high priority. Integration of small numbers of dispersed sources into utility grids has already occurred in a number of instances. Over time we believe that private sector activity will increase in this area. It therefore seems appropriate to phase down Federal funding in FY 1982 for integrating these technologies into the existing electric system; no funds are requested in FY 1983.

Accomplishments in EES have been significant. They have included installing lead-acid batteries in the BEST (Battery Energy Storage Test) facility to assist in load leveling of electricity. Also, we have completed fabrication of the 100-m superconducting test cable at Brookhaven National Laboratory.

Small-Scale Hydropower Development

The small hydro program was begun in 1977 in response to the need to increase energy supplies, diversify sources, and lessen dependence on imported oil. Although hydropower is a mature technology, the small hydro industry had become dormant, due to its inability to compete with cheap oil and large, central power stations.

The Federal small hydro program has helped stimulate a resurgence of State and local government and private interest in this resource. Twenty cost-shared demonstration projects were initiated to prove economic feasibility in several different geographic areas and under differing economic and institutional circumstances. The DOE share of nearly $27 million has been provided under prior year funding, and the overall estimated cost of the 20 projects is $238 million. Six of these demonstration projects are already on-line.

DOE also administered the feasibility study and licensing loan program authorized in Title IV of the Public Utility Regulatory Policies Act of 1978 (PURPA). Over 400 applications were processed and a total of 160 loan agreements were approved.

We have assisted in the identification and reduction of institutional and regulatory barriers at the Federal and State levels by providing technical support on request to a limited number of State Public Utility Commissions and State legislatures, and by providing technical and financial assistance to a majority of the States.

Because hydropower is a mature technology, DOE research and development efforts have been focused on cost-reduction techniques and a few highly specialized applications. In addition, research and analyses are being conducted on minimum streamflow requirements below small hydro plants.

Small hydropower appears particularly appropriate for non-Federal development. The non-Federal sectors have shown steadily increasing interest in small hydro development over the last 2-3 years. Applications to the Federal Energy Regulatory Commission for preliminary permits have increased from nearly zero in many typical years prior to 1977, to over 400 in 1980, and about 1,900 in 1981. The number of licenses granted is also increasing; 57 were granted in FY 1981, and 51 in FY 1980, compared to 12 in FY 1979. It is therefore appropriate to proceed with an orderly phase-out of Federal funding requirements during FY 1982.

The Department requests no new funds for this program for FY 1983. Technical monitoring of the twenty cost-shared demonstration projects will continue and the technical and economic data will be made available to potential developers, the Federal Energy Regulatory Commission, and the States.

We expect to complete formal monitoring of the 160 loan agreements during FY 1983. Staff to support the monitoring and reporting activities will be provided under the Geothermal Program for FY 1983.

Conclusion

Ms. Chairperson, this concludes my statement. I would be happy to answer any questions.

Mr. **Wolpe**. Thank you very much, Mr. Tribble. I thought I had heard a portion of this before in earlier testimony, and I discovered that the first few pages were identical to testimony that you had submitted on another occasion before this committee.

Mr. **Tribble**. That is true. It applies to the entire budget that we put together for 1983. I felt it would still be apropos.

Mr. **Wolpe**. I would like to pursue a piece of that because it is those pages that provide the backdrop for the decisions that you have rendered in the budget proposal that is before this committee.

On page 2 of your testimony—the same page 2 that you had submitted on the previous occasion—you describe various kinds of evidence related to increased energy efficiency. You refer, among other things, to "The miles-per-gallon of fuel for the new domestically produced automobiles has improved by more than 60 percent." Then you conclude, "In every case, the cost of energy has been responsible for the great majority of this improvement."

What is your empirical evidence of that?

Mr. **Tribble**. That was a study done, I believe, by Oak Ridge National Laboratory that indicated that of the conservation that has taken place in the United States between 1972 and 1980, 95 percent could be attributed to price. About 5 percent could be attributed to Federal programs.

Mr. **Wolpe**. Are you aware that during that period of time there were federally mandated standards with respect to fuel economy?

Mr. **Tribble**. Oh, yes.

Mr. **Wolpe**. And that those standards were implemented precisely because of the recognition that the industry was not adapting rapidly enough?

Mr. **Tribble**. In the early stages of the mandated-miles-per-gallon category or requirements, the industry was slightly behind the mandated levels; however, I believe it was in 1978 that the efficiency—the miles per gallon—exceeded the standards. I believe that the data show that ever since then the miles per gallon have been higher than the mandated standards.

Mr. **Wolpe**. Would it be your testimony that, therefore, we should abolish all fuel economy standards with respect to automobile fleet?

Mr. **Tribble**. In my opinion, the demand for improved efficiency by the American public, as well as the competition from foreign automobiles, is driving domestically produced automobiles to the increase in miles per gallon. I believe that will be certainly a strong force which will continue to result in improved efficiency.

Mr. **Wolpe**. Now, as you know, prices are coming down. Are you saying that would be irrelevant essentially, that we should, nonetheless, not attend to the issues of efficiency and just let price determine what happens in the marketplace?

Mr. **Tribble**. I think we all would be naive if we felt the current slump in prices was permanent. I do not feel that way. I think that we should enjoy it while it is here, but we should anticipate that it is not going to be with us forever. Certainly, I believe that automobile manufacturers, as well as industry throughout, share that feeling and they will accommodate it.

Mr. **Wolpe**. Yes, but from the standpoint of public policy, I take it from your testimony, that—in fact, your written testimony refers to "some thought on the part of those who preceded the Reagan administration that our sources of energy were being exhausted." Then you essentially downplay the significance of that issue.

I take it that you just don't think that oil and coal, uranium and natural gas are being consumed at alarming rates, and that this ought to be from a public policy standpoint, not a central concern. You feel that the marketplace will handle all of the needs of this Nation, and it will address effectively the longer term implications of energy consumption.

Is that your testimony, really?

Mr. TRIBBLE. No; I don't think that. I think that we all have to recognize the fact that we are using natural gas in this country at the present time faster than reserves are being added. On the other hand, we should recognize that drilling has turned up only in the last few years, and that during the period of time between 1955 and 1973, there was a constant decline in the activity in the fields.

We are now beginning to see a reversal of that drilling trend. Hopefully, we will come back up to the point where new reserves are equivalent to our consumption.

Mr. WOLPE. You are missing my question. I probably didn't put the point very well.

Mr. TRIBBLE. I'm sorry.

Mr. WOLPE. If I understand what you are telling this committee, it is that the market will do it all. There is essentially no Government role. We no longer need to be concerned because of the improvements that have already been made in energy efficiency, and that is one of the major philosophical rationales for your cutback.

Mr. TRIBBLE. That's right.

Mr. WOLPE. Now, I am trying to at least make sure that I understand what you are saying. Does it really make sense to you——

Mr. TRIBBLE. I am saying——

Mr. WOLPE [continuing]. That there ought to be no public policy concern with addressing the additional utilization of the energy that may well occur because of declining market price?

Mr. TRIBBLE. I think that the public policy should be to let the market handle those things, and quit controlling the price so that the market sends unrealistic signals to the consumer.

Mr. WOLPE. Yes.

Mr. TRIBBLE. We have had a long history of responding to market conditions, and, yes, I believe that the market is adequate to control the usage of fuel.

Mr. WOLPE. Are you saying to me then that you think that the market is the key to consumption——

Mr. TRIBBLE. Yes.

Mr. WOLPE. That as prices fall, more energy is going to be used. Is that correct? More energy—oil for example.

Mr. TRIBBLE. I think that may very well take place. On the other hand, I don't think that it is necessarily a foregone conclusion because I think a lot of people realize that a reduction in price may very well be temporary.

Mr. WOLPE. Well, in other words, price is not the key determinant then.

Mr. TRIBBLE. No.

Mr. WOLPE. Other kinds of factors are.

Mr. TRIBBLE. Price is; there may be a fluctuation downward.

Mr. WOLPE. Can the market make new oil and gas deposits?

Mr. TRIBBLE. I am sorry?

Mr. WOLPE. Can the market make new oil and gas deposits?

Mr. TRIBBLE. Oh, no; certainly not.

Mr. WOLPE. What then is your projection for the useful life of our coal, oil, gas, uranium resources over the next 20-to-50-year period?

Mr. TRIBBLE. I am sorry. I don't have any figures to support that. We would be glad to try to find them for you and give them to you for the record.

[The information follows:]

While it is difficult to predict the individual market choices or energy end users, it is reasonable to expect that conservation and use of renewable energy options will extend the useful life of our coal, oil, gas and uranium resources. However, realistic energy pricing policies make it unlikely that any of these resources would be fully depleted before other energy options displace them. Therefore, although such projections are of limited value, the Energy Information Administration has estimated the number of years that domestic resources can sustain production at the 1980 rate of output. For crude oil and natural gas, including undiscovered recoverable resources, EIA estimates approximately three decades each of production remaining at the 1980 rate of output. For coal, production from demonstrated reserves could be sustained at 1980 rates for an estimated 572 years with additional resources extending production to over 2,000 years. The proven reserve lifetime of uranium at 1980 levels of consumption is estimated to be at least 75 years with a potential reserve lifetime of at least 350 years.

Mr. WOLPE. Well, let me just indicate that I find frankly incomprehensible the proposition that our energy policy should be dictated entirely upon the reliance of market forces.

Surely, market price is one of the reasons why people have consumed less energy in recent years. However, to suggest that our energy policy should be based entirely upon market forces for the indefinite future when every scientist of repute is warning us about the depletion of diminishing fossil fuels over the next several decades, I think is the height of folly. I think it is a good example of where ideology gets in the way of any kind of realistic understanding of what is happening out there.

Beyond that, let me turn to the specific issues of technology at this point.

Mr. TRIBBLE. Yes.

Mr. WOLPE. Is it your view that this administration within the Department of Energy is in fact adopting a posture, consistently, of greater reliance upon market forces to determine where our dollars ought to be invested?

Mr. TRIBBLE. Yes.

Mr. WOLPE. How then do you explain the continued reliance upon the continuing subsidies, for example, for the nuclear industry?

Mr. TRIBBLE. Of course, that is not in my part of the Department of Energy, but I will give you my opinion on it.

Mr. WOLPE. No, but in our opinion, the responsibility is to try to assess the mix——

Mr. TRIBBLE. Right. Sure.

Mr. WOLPE [continuing]. Of investments here.

Mr. TRIBBLE. I think that when you look at the opportunity for the nuclear industry to solve a substantial portion of our future demand for energy, that it certainly deserves a great deal more attention than those parts of the energy supply that are very limited in the future.

Mr. **Wolpe**. Why? Why not allow the marketplace to make that determination? If nuclear power is going to be a commercially attractive energy force in the future, why not allow the marketplace to make that determination? Why should we provide a Government subsidy for that when we are withdrawing the subsidy from other technologies?

Mr. **Tribble**. We are continuing to do research in these other technologies so that when they become economical they will be able to be picked up by the people who need to use them.

Mr. **Wolpe**. Fine, but why don't we apply precisely the same logic, the same standard, the same dimension of cuts to the nuclear industry as you are applying to the technologies within your field?

Mr. **Tribble**. Of course, I am not in a position to evaluate the nuclear technology. I am in a position to evaluate the technologies that we have here. We feel that we are making a realistic approach to those that we have——

Mr. **Wolpe**. I am sorry. I would like you to be responsive to my question.

Mr. **Tribble**. If you will try that again, I will try. I thought that I did.

Mr. **Wolpe**. How can one justify applying the reliance upon market standards only to the conservation renewable technologies and allow subsidies to continue to flow to other technologies as in the nuclear area?

Mr. **Tribble**. We are continuing to subsidize our technologies. This is my point. We are not limiting subsidy to that. We have a——

Mr. **Wolpe**. For example, you are terminating electric systems—zero.

Mr. **Tribble**. That is right.

Mr. **Wolpe**. All right. How do you justify that when we are continuing a very substantial subsidy in the nuclear area?

Mr. **Tribble**. Because the electric energy systems programs that we had appeared to us to be either not proper Federal projects or they were not high enough in priority to justify the activity.

Mr. **Wolpe**. Because the marketplace will do it. Right?

Mr. **Tribble**. Well, we can take them individually and look at the technical merit of any of the things that we are doing. Yes, I think that if they are important, the market will pick them up.

Mr. **Wolpe**. All right. In your statement, you refer to "work on developing new technologies to integrate solar power, wind, photovoltaics, and so forth, into the utility grid is no longer a high priority."

You go on to state: "Over time, we believe that private-sector activity will increase in this area." Then you mention, "No funds are requested in fiscal year 1983."

What do you mean by "private-sector activity?" What is needed? What is your evidence for the assertions that you include within that statement?

Mr. **Tribble**. That particular thing refers to power-conditioning equipment that we were spending money developing. There are already several companies that will sell you the power-conversion equipment that is necessary to put power generated either by photovoltaics or wind or whatever into the grid.

Mr. WOLPE. DOE's design which is at issue here is within the 5-10-kilowatt range.

Mr. TRIBBLE. Yes.

Mr. WOLPE. We are not aware—this committee is not aware—of any company that is prepared to undertake a project within that range of capacity.

Could you please tell me what you are referring to?

Mr. TRIBBLE. Two of the companies that come to mind are Westinghouse and Heliometics.

Mr. WOLPE. Does the equipment or the capability of the industry have the quality of power suitable for the grid?

Mr. TRIBBLE. Sure; in most instances. Actually, there are some problems. If you are going to use a computer system close to that, you may get some harmonics transmitted through the power-conditioning equipment that would give some computer equipment a problem.

On the other hand, we have had a technology for many years which is the plain old motor generator set where you can run a motor with DC current and an electric AC generator accomplished the purposes quite well.

Mr. WOLPE. Are you aware that EPRI says no to that?

Mr. TRIBBLE. No, I am not; I would be interested to hear their comments.

Mr. WOLPE. What specific batteries are being developed specifically for the solar-electric market?

Mr. TRIBBLE. I am going to ask Dr. Savitz to respond to that question. She is much more familiar with the battery technology than I am.

Dr. SAVITZ. Zinc bromine and the redox system.

Mr. WOLPE. Pardon?

Dr. SAVITZ. Zinc bromine the redox battery—the reduction-oxidation battery.

Mr. WOLPE. And what industries are prepared to take up the research that is being discontinued by DOE?

Dr. SAVITZ. In the 1983 budget, we will continue to do some work on the zinc bromine system. We will be looking at it for adaptation to electric vehicles. Exxon has been working on that with us.

Mr. WOLPE. And the other?

Dr. SAVITZ. On the other we have been working with NASA, and that work will not be continued.

Mr. WOLPE. It is just going to be abandoned.

Dr. SAVITZ. Yes.

Mr. WOLPE. What specific batteries does the administration's R. & D. budget for fiscal year 1983 support?

Dr. SAVITZ. We will be continuing some work on the sodium sulfur battery, aluminum air, and zinc bromine. Also, we will be finishing up work on the nickel-iron and lead-acid batteries.

Mr. WOLPE. Would you supply for this committee, in written form, on a project-by-project basis what programs will be continued, what the cost of those programs will be (spent to date), what programs will be abandoned, and which of the ones that are being abandoned will be assumed by private industry?

Dr. SAVITZ. Yes.

[See p. 407 for information requested.]

Mr. WOLPE. Your testimony, Mr. Tribble, argues that the total effect of all Government actions in support of R. & D. programs and conservation renewables is relatively minor. These programs were established in the mid-1970s, as you know.

What in your view is a reasonable time lag between the beginning of an R. & D. program on the one hand, and the visible impact of the fruits of such a program in the marketplace?

Mr. TRIBBLE. Of course, it will vary from one technology to the other. If we take the case of small hydro, for example, this was a technology that has been with us for many years, and it had deteriorated over the years because it simply was not economically competitive with large powerplants and low-cost fuel.

However, when the price of the fuel went up, people began to relook at the potential for hydropower. The Federal program accentuated this. The program brought attention to the fact that there was a lot of capacity available in hydropower—potential capacity.

As a result of that program, a number of people have now made application for the installation of small hydropower sites and equipment. The equipment is availabile. The technology is well known. There is really no reason why the Federal Government should then continue to be involved.

Mr. WOLPE. Are you arguing that the hydropower issue is the typical time frame that one ought to encompass when one is looking at basic R. & D.?

Mr. TRIBBLE. Well, no; we can take the wind program as one that is quite different from that, and it is in the same category.

Of course, you and I know that there have been windmills around for a long time, and they declined because of the same factors that caused hydropower to go down.

In the Government program, the program certainly has moved forward the technology for windpower generation to the point where we now have wind farms in the test stage, and we have companies that are prepared to sell wind farms to anyone who wants to buy them.

We are further going forward with that program to design a more efficient wind machine than the ones that we are now testing. Therefore, this is a technology that is on the verge of competitiveness, and it is competitive in some unusual circumstances.

Mr. WOLPE. I hope that you understand the thrust of my question, which is the proposition that R. & D. programs for the most part which have been in place for no more than 5 or 6 years——

Mr. TRIBBLE. Right.

Mr. WOLPE. And, incidentally, you can take a number of these programs and demonstrate, I think, that some very dramatic impacts on the marketplace, especially in the industrial-conservation area have occurred.

However, putting that aside for the moment, to argue that R. & D. programs that have not yet been moved into the commercialization phase in the marketplace have not had much impact upon our energy program, when you are talking about an R. & D.

program which has been in place for less than 5 or 6 years, I think is absurd.

Are you really serious in suggesting that is an appropriate timeframe in which to evaluate the impact of research and development?

Mr. TRIBBLE. I think that certainly someone could reach the conclusion that you have if you look at this as an overall picture. However, I think that if you look at the individual technologies in detail and look at where we were and what has been accomplished by the Government program and where we are today and also look at the competitiveness of the current technology, then you have got a different picture.

Mr. WOLPE. All right.

Mr. TRIBBLE. Let me move to a different one. That is photovoltaics. Photovoltaics has been around for quite a while, but it has not been economically feasible. The effort that the Federal Government put into photovoltaic research now has brought this technology along to the point where many companies are spending millions of dollars in equipment to build and sell photovoltaic arrays.

We are not completely backing away from this. However, we do feel that it has almost reached the point where the Federal Government participation is certainly no longer needed in the demonstration activities. However, we are going forward with the research into photon conversion and things that we feel will assist the industry to move forward with their products.

Mr. WOLPE. In recommending zero funding for electric energy systems, I take it that you have come to the conclusion that the future benefits to the American public in continuing Federal involvement in that research area are zero.

Mr. TRIBBLE. We feel that the benefits that those programs have were not adequate to justify our borrowing money to conduct that work.

Mr. WOLPE. Borrowing money?

Mr. TRIBBLE. Yes. Every dollar that we spend on research this year is a dollar that we have to borrow and add to the Federal deficit.

Mr. WOLPE. I am delighted——

Mr. TRIBBLE. And we don't feel that is worth it.

Mr. WOLPE. I am delighted to hear that observation. Some of us are trying to deal with that problem within the Congress.

Mr. TRIBBLE. I wish you luck.

Mr. WOLPE. I think the problem is over in the executive branch in this instance.

Could you please present in detail for the record your complete cost-benefit analysis of this program which has led to your conclusion?

If you would like to present any of that data right right now verbally, we would welcome it. If not, I would certainly like to have that in the record.

Mr. TRIBBLE. Yes. We would be pleased to submit it for the record.

[The information follows:]

Benefit assessment studies of the Electric Energy Systems research program have been carried out in the past for the purpose of establishing relative priorities of proposed research activities. Even the most recent studies are out of date because assumptions regarding such basic parameters as cost of primary fuels, interest rates, inflation rates and expected penetration of advanced technologies are being impacted significantly by the President's economic recovery program. Thus, we do not have cost/benefit analyses which reflect the current cost/benefit relationship of improved electric energy system technology. The decision to close out this program was not based on such analyses. As I stated earlier in my testimony (line 155–161), ". . . we have carefully reviewed every proposed project, and we decided either that they were no longer appropriate for Federal support, or they were not of a high enough priority to borrow money for. Consequently, we have requested no funds for this program in 1983."

Mr. **Wolpe**. Also for the record, we would appreciate it if you could summarize now and submit in detail for the record an account of all of the prior R. & D. investments that have been made by DOE in the electric energy systems and energy storage for each of the projects that were funded in fiscal year 1981 but for which no funds have been requested in fiscal year 1983.

For each of the projects, we would like to have the work accomplished to date indicated, the amount of R. & D. yet to be completed in order to benefit the public, the estimated cost of the remaining research and development, and the projected future economic impact should the work not be carried forward by industry or by the utilities.

Mr. **Tribble**. We will make every effort to get that together.

[Material to be supplied follows:]

12. Q. Summarize now and submit in detail for the record an account of all prior R&D investments made by DOE in Electric Energy Systems and Energy Storage for each and every project funded in FY 1981 but for which no funds have been requested in FY 1983. For each project, list the work accomplished to date, the amount of R&D yet to be completed in order to benefit the public, the estimated cost of the remaining R&D and the projected future economic impact should the work not be carried forward by industry or the utilities.

A. We offer the following list of Electric Energy Systems (EES) and Energy Storage (ES) projects for the record (projected future economic impacts should work not be continued cannot be assessed). Since the pace of R&D depends on the occurence of breakthrough, which cannot be predicted, we can not estimate costs for remaining R&D with any accuracy.

Electric Energy Systems

1. Project: High Voltage Technology (ac and dc)

- Advanced Circuit Breaker, Surge Arrester and ancillary devices
- Higher Efficiency Materials/Equipment
- System assessments
- Electromagnetic Pulse (EMP) impact
- Superconducting generator

Progress: All prototype devices and higher efficiency material assessments will be completed with FY 1982 funds. Basic analysis of molecular structure of higher efficiency materials, EMP analysis, superconducting generator testing, and system assessments will be terminated.

2. Project: Underground Transmission

- Superconducting cables
- Ambient high capacity 1200kv cables
- Submarine cables

Progress: Brookhaven National Laboratories' superconducting cable has been fabricated and a 100-meter segment installed in its tested cryostat. Power tests will be completed in FY 1982, but impulse tests will not be initiated. Ambient prototype cables will be fabricated but not tested with funds committed through in FY 1982. Deep water submarine cable research has reached the point as well as repair splices and accurate means of locating and retrieving faulted sections.

3. Project: Electric Field Effects

- Small animals
- Cell/tissue
- Risk assessment for human hazard

Progress: Some effects have been found, but remaining research is aimed at finding whether these effects pose any hazard to humans. Finally, the risk assessment will look at all research to date, determine any gaps and evaluate hazard levels. This will be initiated in FY 1982 to determine how such a risk assessment should be conducted.

4. Project: Storage Applications (Electric Utility Load Leveling)

- Battery Energy Storage Test (BEST) Laboratory
- Advanced Battery Technology Testing and Evaluation
- Compressed Air and Underground Pumped Hydro Storage Technology Assessment

Progress: All compressed air and underground pumped hydro storage evaluation projects will be completed during FY 1982 with FY 1982 and prior year funds. DOE participation (currently on 50/50 basis with EPRI) in the BEST facility will be phased out and responsibility for continued operation and testing of advanced batteries at the facility will be transferred to EPRI and/or the utilities; sufficient funds have been committed through FY 1982 to complete the base line facility, to prepare the second bay for testing of small (500 kwhr) advanced prototype batteries, and to operate the facility for up to 2 years. One 500 kwhr advanced battery (a string of 10 prototype zinc-chloride modules) will be tested at BEST during FY 1983 with prior year funds. Plans to test and evaluate competing advanced battery prototypes (sodium-sulfur, zinc-bromine, etc.) at the BEST laboratory have been terminated.

5. Project: System Coordination and Control

- Emergency Detection and Control
- Operation of Multi-terminal High Voltage Direct Current (MTDC) Systems
- System Dynamic Performance
- Control of Very Large Scale Systems

Progress: In Emergency Detection and Control, fundamental progress has been made in estimating the likelihood of system failures, in developing control strategies for abnormal system-operating states and in developing concepts for decision aids for assisting operators to rapidly restart the system after major blackouts. In MTDC systems, advanced concepts have been developed for designing power flow modulation controls. In Systems Dynamic Performance, basic advances in sensitivity theory for linear multi-variable control systems have been made as well as new results on the stability of large power systems. In the Control of Very Large Scale Systems, the development, testing and evaluation of an advanced automatic generation control algorithm on the Wisconsin Electric Power Systems is complete. New theoretical results in decentralized control theory were also achieved.

6. Project: Communication and Operation Technologies

- Energy management for distributed systems
- Protection and safety needs of distributed systems
- Harmonic impacts
- Power conversion concept
- Renewable energy source analysis

Progress: The accomplishments include an analysis of tests of the capabilities of heat and/or cold storage technologies to assist in the control of power systems peak electrical demands, completed field test of load management systems for residential customers, the development of mathematical models to study the interaction between wind turbines and conventional power systems, development of a family of advanced power conditioners for AC/DC and DC/AC conversion, development of advanced concepts for the protection of distributed systems containing energy storage and production equipment, the development of analysis tools to determine the benefits of novel distributed-systems designs, the completion of the first phase of the initial phase of research on data coding methods, electrical noise analysis and data transmission technologies required for communication in distributed electrical power systems.

Energy Storage

7. Project: Non-Aqueous Batteries

Progress: The sodium-sulfur molten salt battery system, lithium-iron sulfide battery system, and room-temperature lithium systems are still in the feasibility determination stage. Energy densities of more than double that of advanced lead-acid have been demonstrated in the laboratory, but major improvements remain to be made in cycle life.

8. Project: Metal-Air Battery Development

Progress: Present work on the iron-air battery focuses on problems with electrodes, separators, and the need for an oxygen-evolution catalyst.

9. Project: Supporting Research

Progress: This project covers basic and applied research in a broad area of electrochemistry and applied research into materials for electrochemical systems. Areas of inquiry include research on corrosion-resistant seals, insulators and supports. Studies include thermodynamics, kinetics, electrocatalysts, and morphology of battery electrodes; investigation of battery performance phenomena; and improvement in battery design and scale-up criteria. Some activities have led to improvements in lead-acid batteries now on the market.

10. Project: Electrochemical Processes

Progress: This level-of-effort research covers electrolysis membranes, electro-organic synthesis, air electrode development and fuel cells for transporation, with possible applications in industrial processes.

11. Project: Stationary Applications

Progress: Activities covered in this project include the Hawaii Natural Energy Institute Battery Storage Assessment, Evaluation of Customer-Side-of-the-Meter Battery Storage, the Wind Energy Storage Assessment, the Small Commercial Photovoltaics Storage Assessment, the New York State Energy Research and Development Authority Load Management/Storage Application, and Battery Modeling Studies. These activities have produced reports and other information useful to the private sector as battery storage options are considered.

12. Project: Battery and Systems Testing

Progress: A large part of this has been for construction of the National Battery Test Laboratory. The standardized tests and impartial data collection and analysis available only at this facility will enable battery manufacturers to demonstrate the true merit of their batteries for EV use. Testing to date has been on advanced lead-acid and nickel-iron batteries.

13. Project: Aqueous Non-Flow Battery Systems

Progress: Specific energy of 68 watthours per kilogram has been demonstrated with a cycle life of 179 cycles for nickel-zinc batteries. Corresponding specific energies for the other systems are 48 watthours per kilogram for nickel-iron and 42 watthours per kilogram for lead-acid. General Motors has invested heavily in proprietary nickel-zinc battery research.

14. Project: Aqueous Flow-Battery Systems

Progress: Development of the iron-chromium system has reached the point where a marginally operative laboratory scale model exists. It faces remaining problems in membrane design, electrode performance, and the enhancement of the preferred chromium species.

15. Project: Thermal Storage

Progress: Work on carbonate salts for mid- and high-temperature applications; phase-change media behavior with construction materials, and development of thermal storage for use in residences have yielded results which indicate potential for saving large amounts of oil. Research on direct-contact heat exchange for solar applications and thermal storage and transport by reversible chemical reaction shows long-term promise to increase heat transport efficiency. There is still a need to improve properties of phase-change materials, improve system designs for direct-contact heat transfer, and optimize their action scheme for thermal storage and transport.

16. Project: Chemical/Hydrogen Storage

Progress: Prototype electrolysis systems have been tested including a solid-polymer electrolyzer, advanced alkaline electrolyzer and a static feed system with the potential to electrolyze brackish water. Associated research on materials, recovery of hydrogen from industrial waste streams, thermochemical methods for water splitting, and development of chemical heat pumps to upgrade waste heat also show promise of energy savings. Continued research to improve catalysis, electrolytes, membranes, and current collectors is needed to increase efficiency of electrolysis systems. Better materials and improved system design are needed for improving hydrogen recovery from waste streams and performance of chemical heat pumps.

17. Project: Mechanical Storage

Progress: Research to develop improved composite materials and rotor designs have resulted in flywheels with an energy density of 45 wh/kg. A flywheel is being fabricated for incorporation into an experimental electric bus in cooperation with DOT. Continued research is needed on long-term cycling effects on these materials and to investigate fatigue and creep properties unique to vehicular flywheels.

18. Project: Underground Storage

Progress: For seasonal thermal storage, aquifer injection testing has been completed in the 120 degree Fahrenheit - 195 degree Fahrenheit range. Computer modeling to predict heat and fluid flow in aquifers is completed and in good agreement with experimental results. For compressed air energy storage, reservoir stability criteria have been completed for salt domes and hard rock. An experimental test facility to confirm stability in aquifers is being designed and constructed. Further research is needed to evaluate high-temperature characteristics of aquifers to minimize geochemical and geological problems for seasonal storage. System designs for advanced compressed air energy storage systems need to be improved in order to eliminate the need for oil firing.

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19. Project: Magentic Storage

Progress: Component development and automated control systems are completed for a 10 kwh system. The equipment, after verification testing is complete, will be shipped this summer to Tacoma, Washington, for installation on the BPA Pacific alternating current transmission line. Some feasibility studies have also been completed for large-scale magnetic storage, but all present work is funded by the Electric Power Research Institute.

Mr. WOLPE. Very candidly, had you come before this committee and simply indicated that budget constringency forced decisions that you were not really happy with but you have to go along and do that, we may disagree with judgments made, but at least I think that we could have understood that argument.

However, to argue on the philosophical basis in the first instance that we are simply not going to be involved because the marketplace will handle it all, when in fact there are whole parts of the energy budget where your substantial involvement continues, I think some of us find an untenable proposition.

Then to argue beyond that on the basis of the assertion that indeed the market will take it, and commercial industries will pick up a large piece of the research that is being abandoned, I do not think there is any empirical evidence to demonstrate that.

I think that at least we ought to be very careful that we are not really abandoning some pretty important kinds of initiatives.

I want to pursue that subsequently when we have you respond to some of the panel that will be coming forward in just a moment.

At this point, let me yield to my colleague, Mr. Lujan.

Mr. LUJAN. Thank you, Mr. Chairman.

I have a couple of concerns on the energy storage systems. You had asked OMB for some money and OMB cut it out. Therefore, there is that indication, as the chairman was saying——

Mr. TRIBBLE. Yes.

Mr. LUJAN. That you would have liked to have the money in the budget request, but it was beyond your control. I guess you are right in answering the questions the way you did, namely, that we are under budget constraints right now and are looking for every way to reduce expenditures.

I am not happy with cutting out energy storage. The battery program is probably the best illustration. We don't have the kind of batteries that we need. Further research needs to be done. However, as a matter of fact, private industry is doing research on different kinds of batteries.

You were talking about photovoltaics as I came in. I was in Santa Fe about 3 weeks ago where they dedicated a house that the energy bill would zero out. It has all the innovative heating and cooling systems. They even have a hot tub outside for demonstration. Also, they have generated electricity by photovoltaic means. They sell it to the Public Service Co. of New Mexico when they don't need it, and they buy it when they do. They claim it will result in a zero energy bill for the house.

That is the good news. The bad news is that the cost is $35,000 and that is beyond the reach of someone who has to build a house and add this to it.

I don't know that you could answer the question any differently than anyone else. We wish we could go on with it.

Perhaps, I might ask you in the area of photovoltaics, do you foresee funding for further development of this work?

Mr. **Tribble**. Yes. We are continuing with that work. We are converting the work to more basic research, rather than the building of hardware and the demonstration of arrays.

We are trying to improve the efficiency of conversion of the photovoltaic cells. We are trying to provide the industry with information which will enable them to lower the cost per peak watt of the installation so that the major expense that you just mentioned that was involved in this house will be substantially reduced.

There have been good reductions that have been made. On the other hand, we, as you mentioned, have a long way to go before that technology will be competitive with the grid system.

In many instances where there are stand-alone facilities and no grid is available, then this is an excellent technology. We feel that there is a market there for this. The industry is serving that market, and the industry itself is making progress in lowering cost so as to broaden the market.

Mr **Lujan**. We are also concerned about the research on transmission lines which I suppose will be totally cut out? Is that right?

Mr. **Tribble**. Generally, yes, on the transmission system. Now, we are going forward with some research in this year that we think will reach a very good end point. We have, as you know, built the superconducting cable. It is going to undergo tests in this year. It will be available for anyone else who may want to conduct further tests after this year.

Mr. **Lujan**. That is one of the areas where probably industry would not readily move in and pick up, would they?

Mr. **Tribble**. I certainly doubt that industry would have built it. It has been an expensive development. However, that part is behind us. Now we are going forward with some work in the development of undersea cables so that we can transmit power from one island to another. Hawaii is particularly concerned with this problem.

Mr. **Lujan**. Are we continuing that part?

Mr. **Tribble**. Yes, we are.

Mr. **Lujan**. So we are really not cutting it out completely. We are redirecting funds in many instances.

Mr. **Tribble**. Yes.

Mr. **Lujan**. What programs do you foresee will not have funding? I mentioned batteries previously—and industries' involvement in working on them? You know, this is necessary if we are going to get to electric cars and that sort of thing.

Do you see forward movement? Maybe I ought to ask Dr. Savitz. Do you see forward movement on developing a battery that will go the endurance limit or more than the endurance limit if necessary?

Mr. TRIBBLE. We are asking for $7.2 million to continue that work. That is not work in the storage program, but it is in energy research.

Mr. LUJAN. Oh, so that will be continued?

Mr. TRIBBLE. So that work on a number of the battery systems will continue. Yes.

Mr. LUJAN. What about BEST?

Mr. TRIBBLE. The BEST facility? We are withdrawing from that after this year; however, the Public Service Electric & Gas Co. and EPRI have picked it up. It is my understanding that they will go forward with the utilization of that facility.

Mr. LUJAN. All right. Thank you, Mr. Chairman.

Mr. WOLPE. Could I just pursue the question that Mr. Lujan was raising?

You said that much of this work on batteries will continue. What is the total dollar amount that is being requested now with respect to batteries?

Mr. TRIBBLE. It is $7.2 million.

Mr. WOLPE. What was it last year.

Dr. SAVITZ. It is $30 million this year.

Mr. WOLPE. What was it the year before that?

Dr. SAVITZ. It was $43 million.

Mr. WOLPE. So it has gone down from $43 million to $30 million to $7 million in 2 years, and you are telling us that much of this work is going to continue?

Mr. TRIBBLE. Certainly, some of it is. I think in the past years, we were doing some research on almost every kind of couple that would create an EMF. A lot of those, of course, have been dropped. However, we are going forward with work in those areas where there appears to be promise.

Mr. LUJAN. I don't think you said that it is not going to continue. It is just $7.2 million because you said that EPRI was going to pick up where DOE is leaving off.

Mr. TRIBBLE. In the BEST facility I am not aware of the level of activity being financed by EPRI, but certainly they are participating now, and they will continue to participate in the BEST facility.

Mr. LUJAN. Well, we will have witnesses from EPRI today.

Mr. TRIBBLE. Yes.

Mr. WOLPE. We will put that question directly to them.

Mr. LUJAN. Thank you.

Mr. WOLPE. Thank you. We look forward to having you back in a few minutes, Mr. Tribble, because I would like to get some response to the testimony that will be presented by the industrial panel.

Mr. TRIBBLE. Thank you.

Mr. WOLPE. I am pleased to welcome at this point Dr. Thomas Schneider, the department director for energy utilization and conservation technology of Electric Power Research Institute; Mr. Lowell Endahl, director of research, the National Rural Electric Cooperative Association; and Mr. Lester H. Fink, the Institute of Electric and Electronic Engineers, Inc.

I see a fourth name.

Dr. **Schneider**. I will introduce Mr. Fickett in a minute.

Mr. **Wolpe**. All right.

Dr. **Schneider**. This is Mr. Arnold Fickett, department director for advanced conversion and storage of the Electric Power Research Institute

Mr. **Wolpe**. Fine. Very good.

Dr. Schneider, why don't you then proceed.

Again, all of your testimony will be submitted in its entirety in the record, and we invite you to summarize your remarks at this point.

STATEMENT OF DR. THOMAS R. SCHNEIDER, DEPARTMENT DIRECTOR, ENERGY UTILIZATION AND CONSERVATION TECHNOLOGY, ELECTRIC POWER RESEARCH INSTITUTE, ACCOMPANIED BY ARNOLD FICKETT, DEPARTMENT DIRECTOR, ADVANCED CONVERSION AND STORAGE, ELECTRIC POWER RESEARCH INSTITUTE

Dr. **Schneider**. Thank you very much. Good morning. I am Tom Schneider, director, energy utilization and conservation technology department at EPRI.

On March 8, 1981, I had the opportunity to testify before this subcommittee in my previous position as assistant director for the energy management and utilization division of EPRI.

Accompanying me is Mr. Arnold Fickett, director, advanced conversion and storage of EPRI. Since my last testimony, my position at the institute has changed. Arnold Fickett is now the person with direct responsibility for our energy storage activities.

To insure continuity with our previous testimony, I am presenting our official testimony and the summary of it, and Mr. Fickett is available to respond to more specific questions about our current activities.

Mr. **Wolpe**. Fine.

Dr. **Schneider**. On behalf of EPRI I thank you for the opportunity to speak before this committee and update the testimony we presented previously on December 8 concerning our perspective on the need and opportunities for continuing Federal role in energy storage and electric energy systems R. & D.

This previous testimony and my remarks today are my personal views as a result of my close association with the Government's programs in this area for the past 8 years.

Previously, I reviewed EPRI's background and charter, examples of the R. & D. projects which have involved EPRI in Federal coordination, and the continued need for Federal support of energy R. & D. I also reviewed the need for and benefits of electric energy systems and energy storage technology in reducing oil dependence, in increasing utility system reliability, in reducing environmental impact, and in lowering the cost to the customer.

Today we will focus on the major changes that are occurring in our relationship and partnership with DOE as a result of significant change in the Federal R. & D. role. We will point out that DOE has taken advantage of opportunities to transfer appropriate work to the private sector. We will also review areas that seem to fall within the charter of the new Federal role in energy R. & D. but which are endangered of not being adequately funded.

Finally, we will suggest a minimal 1983 budget that would be appropriate if DOE is to fulfill the new Federal role and continue to remain a participant in the R. & D. programs of the private sector.

During this past year we have worked closely with DOE to aid the transfer of near-term R. & D. to the private sector. Several examples of this, coming particularly out of the energy storage area, include: Underground pumped hydro energy storage work which has largely been transferred to the private sector after the successful completion of a joint-DOE-EPRI-utility effort in exploring the concept of underground pumped hydro.

Continuation of the concept of the storage battery electric energy demonstration [SBEED] project, which was originally largely DOE-funded, by EPRI preparing to proceed with a scaled-down project—scaled down from 30-megawatt hours to 1-megawatt hour and changed from a demonstration project to a technical evaluation at the BEST facility in New Jersey.

DOE's intent to conclude work on both near-term and long-term compressed air energy storage with the transfer of the sole remaining project in this area, an evaluation of aquifer air storage, to EPRI later this year or early next year.

DOE reduced its role in small hydrodevelopment. EPRI has agreed to assist in transferring the technology from the DOE small hydrodemonstration program and to pursue with DOE continued cooperation and available support for development and evaluation of approaches to lower cost small-scale hydrosystems.

Additionally, DOE has concluded its electrolytic hydrogen projects. EPRI is making use of the results of that work with the installation of two onsite hydrogen generators that will be demonstrated on utility systems in 1982.

We endorse DOE's efforts to transfer these projects to the private sector and applaud the sensitivity that had been demonstrated in DOE's approach to accomplishing these projects.

DOE is attempting to transfer near-term work to the private sector, and it is not simply abandoning valuable efforts. Virtually all of the work being taken over by EPRI is being done by reprograming our existing budget. That existing budget is really our only source for funds.

Reprograming has been done by terminating lower priority work, by reducing basic and supporting R. & D., and withdrawing from long-term R. & D. As a result, there is virtually no long-term EPRI R. & D.

Additionally, the reduction in supporting R. & D. results in a significant risk that the needed technical advances will not occur. Valuable projects are often terminated because of unforeseen problems requiring extensive supporting R. & D. which destroy the enthusiasm for continued development and make further progress impossible.

Thus, DOE's ability to assume responsibility for the long-term higher risk activity and for support R. & D. is essential to the successful continuation of our programs.

Yet the proposed 1983 DOE budget does not provide adequate funding for either long-term or supporting R. & D. in electric energy systems or energy storage.

Specifically in electric energy systems, we have previously discussed the complementary nature of the DOE and EPRI programs. In general, DOE has pursued R. & D. for the longer term and higher risk, which EPRI has pursued research in the nearer term and lower risk. This coordinated approach has been very beneficial to the Nation's electrical utilities to help insure reliable and efficient supply of electric energy.

In our previous testimony, we indicated our belief that this complementary and cooperative approach should continue. Specific project areas which are desirable to continue include: basic and applied research into the causes of electric insulation failure; advanced communications concepts for electrical systems; applied research applicable to multiterminal, high-voltage, direct-current transmission systems; applied research on advanced underwater cables; applied research on advanced electrical insulation; development of superconducting technology for power system applications; and development of methods to predict and control the dynamic performance of power systems.

EPRI's budget in electrical systems is essentially level at $30 million per year. A complementary DOE program of this magnitude would be desirable.

With regard to energy storage systems research, most impact of the proposed DOE energy storage budget will be felt in the area of advanced batteries. Battery commercialization is at least a decade away and the profit potential is nearly two decades away. Hundreds of millions of dollars in private resources will be needed to reach the point of achieving a positive cash flow. The private sector depends upon Federal support to achieve scientific and engineering feasibility at which time the private sector can assume the risk and responsibility for achieving and demonstrating economic feasibility.

We would expect that without some Federal support, cost shared by both battery developers and EPRI for advanced battery R. & D., and testing of developmental batteries in the BEST facility, many of the battery systems will fail without a fair evaluation.

To a lesser degree, compressed-air energy storage, hydrogen, and small hydro are dependent upon Federal support for investigations of novel materials and improved new concepts. For example, compressed-air storage continues to depend upon supplemental firing with oil or gas, whereas advanced concepts do exist which could substantially reduce or eliminate the need for supplemental fuel firing. However, because of their long-term, high-risk nature, these concepts will be pursued only if Federal funds are made available.

If DOE is to provide minimal support of the private sector as it attempts to move forward with energy storage and hydroelectric technologies, the budget detailed in our full testimony would be an appropriate level of activity.

This budget is about half of the total for the respective 1982 DOE activities, and it compares to a 1983 EPRI budget in energy storage and hydroelectric of about $10 million. I might add that the total private sector budget for these activities is approximately $50 million.

We believe that a DOE budget at this level is consistent with the need to be austere while providing for an orderly and effective transfer of energy storage R. & D. to the private sector. It falls clearly within the categories of long-term R. & D. that DOE accepts as its role, and it should allow the private sector, including EPRI, to continue moving forward with DOE without the fear that the major technologies will be terminated for lack of a supporting R. & D. program.

In conclusion, I would like to stress the points that I made at the end of my last testimony. That is that we believe that a continuing Federal role does exist in long-term, high-risk electric energy systems and energy storage research.

While EPRI concurs with the efforts to increase private sector energy R. & D., we are realists in recognizing that increased investments at present are discouraged by the uncertainty of technical success, the weakness of the market, and the long development time.

Therefore, we cannot foresee rapid increases in industry support for research and development.

EPRI is working to accommodate its program to the changing direction in federally sponsored energy R. & D., but our ability to meet this challenge is limited by our essentially fixed budget that we have.

Improvements in the financial health of utilities could do much to allow the industry to accommodate some of the changes that are being contemplated. Such improvements will, however, take time; hence, adjustments in Federal support of R. & D. should not be made at the expense of the momentum and progress that is being made in the ongoing programs of national importance in electric energy systems and energy storage.

I would again like to thank you for this opportunity to testify. I am prepared to respond to questions.

[The prepared statement of Dr. Schneider from December 8, 1981, and March 25, 1982, follow:]

TESTIMONY OF THOMAS R. SCHNEIDER
DIRECTOR, ENERGY UTILIZATION AND CONSERVATION TECHNOLOGY DEPARTMENT
ELECTRIC POWER RESEARCH INSTITUTE
Before
Subcommittee on Energy Research and Production
of the Committee on Science and Technology
U. S. House of Representatives
Washington, D. C.
March 25, 1982

Madame Chairman,

Good afternoon. I am Thomas R. Schneider, Director, Energy Utilization and Conservation Technology Department of the Electric Power Research Institute (EPRI), Palo Alto, California. On December 8, 1981, in my previous position as Assistant Director, Energy Management and Utilization Division of EPRI, I had the opportunity to address this committee in regard to the 1982 DOE Electric Energy Systems and Energy Storage R&D Programs. From 1977 to 1982, I was directly responsible for EPRI's energy storage R&D efforts. Prior to joining EPRI I worked in the electric utility industry and was principal investigator on the major joint ERDA (AEC) - EPRI project, "An Assessment of Energy Storage Systems Suitable for Use by Electric Utilities" which was completed in August of 1976 and provides the technical and economic basis for the direction of both EPRI and DOE's program in electric energy storage. Accompanying me is Mr. Arnold Fickett, Director, Advanced Conversion and Storage Department of EPRI, who is responsible for EPRI's efforts in energy storage, hydroelectric, fuel cells, and hydrogen. Mr. Fickett has more than 25 years of experience in these systems working both for EPRI and a major equipment supplier.

On behalf of EPRI, I thank you for the opportunity to appear before this committee and update testimony (attached) we presented to this committee on December 8 concerning our perspective on the need and opportunity for a continuing Federal role in energy storage, electric energy systems and hydroelectric R&D. This previous testimony and my remarks today are my personal views and the result of my close association with the DOE program over the last five years. On December 8, I reviewed EPRI's background and charter, examples of R&D projects which have involved EPRI and Federal coordination, and the continued need for Federal support of Energy R&D. I also reviewed the need for and benefits of electric energy systems and energy storage technologies in reducing oil dependence, in increasing utility system reliability, in reducing environmental impact and in lowering cost to the consumer.

Today, we will focus on the major changes that are occurring in our partnership with DOE as a result of the significant change in the Federal R&D role. We will point out that DOE has taken advantage of every opportunity to transfer appropriate work to the private sector. We also review areas that seem to fall within the charter of the new Federal role in energy R&D, but are in danger of not being funded, and we will discuss the likely impacts of this. Finally we will suggest a minimal 1983 DOE budget for the areas of our concern that would seem appropriate if DOE is to fulfill this new Federal role, and remain a participant in the R&D programs of the private sector.

During the past year we worked closely with DOE to facilitate the transfer of near-term R&D to the private sector as noted by the examples below which pertain primarily to energy storage R&D:

- Underground pumped hydro (UPH) energy storage was transferred to the private sector after developing detailed designs and cost estimates through a series of projects cost-shared with EPRI. EPRI has, along with potential suppliers, assumed responsibility for the development and verification of improved components for UPH.
- DOE has terminated the Storage Battery Electric Energy Demonstration (SBEED) which would have provided a full scale lead-acid battery demonstration in a utility system. In response, EPRI has proposed a scaled down project, reduced in size from 30 MWh to 1 MWh and changed from a demonstration project to an evaluation of the battery in the Battery Energy Storage Test (BEST) Facility in 1983.
- DOE intends to conclude work on both near-term and long-term compressed air energy storage (CAES) with the transfer of its sole remaining project in the area, an evaluation of aquifer air storage, to EPRI in 1982-1983.
- DOE has reduced its role in small hydro development. EPRI has agreed to assist in technology transfer from the DOE small-hydro demonstration program and to pursue, with DOE cooperation and any available support, the development and evaluation of approaches to lower small-hydro capital cost.
- DOE has reduced its electrolytic hydrogen projects. EPRI, with member companies, is benefitting from the transfer of this technology through two on-site hydrogen generators that will be demonstrated on utility systems in 1982.

We endorse DOE's efforts to transfer these projects to the private sector and applaud the sensitivity that has been demonstrated in DOE's approach to accomplish this: DOE clearly is attempting to transfer near-term work to the private sector and is not precipitously abandoning valuable projects. For example, the test to evaluate aquifers for CAES air storage will be supported by DOE until 1983 when EPRI can assume full responsibility. Also, the BEST Facility contract was extended into 1983 with continued DOE cost share to enable EPRI an opportunity to explore the possibility of additional private sector support.

Virtually all of the work being taken over by EPRI is being done by reprogramming existing budgets, which is our only alternative at this time. This has been done by terminating lower priority work, reducing supporting R&D, and withdrawing from long-term R&D. As a result, there is virtually no long-term EPRI R&D and additionally the reduction in supporting R&D results in a significant risk that the needed technical advances will not occur. Viable projects are often terminated because unforeseen problems, requiring extensive supporting R&D, destroy the enthusiasm for continued development. Thus DOE's ability to assume responsibility for the longer-term, higher-risk activities and for supporting R&D is essential. Yet the proposed 1983 DOE budget does not provide continued funding for either long-term or for supporting energy storage R&D activities.

Electric Energy System Research

Previously we discussed the complementary nature of the DOE and EPRI programs in electrical systems R&D. In general, DOE has pursued R&D that is longer term and higher risk while EPRI has pursued research that is shorter term and lower risk. This coordinated approach has been very beneficial to the nation's electric utilities to help ensure reliable and efficient supply of electric energy. In our previous testimony we indicated our belief that this complementary and cooperative approach should continue. Specific project areas which are desirable to continue include:

- Basic and applied research into the causes of electric insulation failure.
- Advanced communication concepts for electrical systems.
- Applied research applicable to multi-terminal high voltage direct current systems.
- Applied research on advanced underwater cables.
- Applied research on advanced electrical insulation materials.
- Development of superconducting technology for power system applications.
- Development of methods to predict and control the dynamic performance of power systems.

EPRI's budget in Electrical Systems is essentially level at $30 million per year. A complementary DOE program of this magnitude is desired.

Energy Storage System Research

The most severe impact of the proposed DOE energy storage budget will be felt in the area of advanced batteries. Battery commercialization is at least a decade away and profit potential nearly two decades away. Hundreds of millions of dollars of private resources will be needed to reach the point of achieving a positive cash flow. The private sector depends upon Federal support to achieve scientific and engineering feasibility at which time the private sector can assume the risk and responsibility for achieving and demonstrating economic feasibility. We would expect that without some Federal support (cost shared by both battery developers and EPRI) for advanced battery R&D and evaluation of small developmental batteries in the BEST Facility, many of the battery systems will fail without a fair evaluation. To a lesser degree CAES, hydrogen, and small hydro are dependent upon Federal support for investigations of novel materials and improved new concepts. For example, CAES presently uses a small amount of supplemental firing with oil or gas, whereas advanced concepts could substantially eliminate the need for oil and gas firing. However because of their long-term, high risk nature these concepts will be pursued only if Federal funds are made available.

If DOE is to provide minimal support of the private sector as it attempts to move forward with energy storage and hydroelectric technologies, the following budget for 1983 is appropriate:

	Activity	($ millions)
o	Electrochemical and materials research for advanced batteries	2.5
o	Continued R&D on promising advanced batteries (sodium sulfur, zinc-halogen, and nickel iron)	9.0
o	Exploratory R&D on new and long-term storage concepts, including other battery systems, flywheels, SMES, hydrogen, etc.	4.0
o	Battery testing and evaluation (including providing advanced 500 kwh battery systems for verification in the BEST Facility)	6.5
o	Supporting R&D on advanced concepts, especially air and thermal storage media for CAES	1.5
o	Small hydro technology transfer and advanced hydro development	3.0

This budget is about half the total for the respective 1982 DOE activities and compares to an 1983 EPRI budget of about $10 million. I might add that the total private sector budget for these activities is approximately $50 million. We believe that a DOE budget at this level is consistent with the need to be austere while providing for an orderly and effective transfer of energy storage R&D to the private sector. It falls clearly within the categories of long-term R&D that DOE has accepted as its role and it should allow the private sector, including EPRI, to continue moving forward with DOE without the fear that major technologies will be terminated for lack of a supporting R&D program.

TESTIMONY OF THOMAS R. SCHNEIDER

Assistant Director, Energy Management and Utilization Division
Electric Power Research Institute
Before
Subcommittee on Energy Research and Production
of the Committee on Science and Technology
U.S. House of Representatives
Washington, D.C.
December 8, 1981

Madame Chairman,

Good afternoon. I am Thomas R. Schneider, Assistant Director, Energy Management and Utilization Division of the Electric Power Research Institute (EPRI), Palo Alto, California. On behalf of EPRI I would like to thank you for the opportunity to appear before this Committee and present information on our perspectives on future energy R&D, the need for continuing federal government sponsored R&D and priorities for continuing with R&D in electric energy systems and energy storage. This testimony is in response to your invitation of November 24, 1981 directed to Mr. Richard Rudman, our Director of Information Services.

I will present a short summary of our official testimony and am prepared to respond to questions from the committee. Accompanying me is Mr. Richard Steiner, Director, Power Systems Department of EPRI's Electrical Systems Division who is prepared to answer questions on electrical systems R&D. Mr. Steiner has more than 30 years of experience in electrical systems working both for an electric utility and a major equipment supplier. I am prepared to answer questions on energy storage. From 1977 to last year I was Program Manager, Energy Storage for EPRI and was directly responsible for EPRI's energy storage R&D efforts. Prior to joining EPRI I worked in the electric utility industry and was principal investigator on the major joint ERDA (AEC)- EPRI project, "An Assessment of Energy Storage Systems Suitable for Use by Electric Utilities" which was completed in August of 1976 and provides the technical and economic basis for the direction of both EPRI and DOE's program in electric energy storage.

EPRI RESEARCH ACTIVITIES

The Electric Power Research Institute was established by the electric utility industry in 1973 to plan and manage a comprehensive research, development and demonstration program for the entire electric utility industry and its ratepayers. EPRI is supported by voluntary contributions from investor-owned, government-owned and cooperatively-owned electric utilities across the nation. In 1981, EPRI will expend approximately $250 million on research, development and demonstration to help ensure an adequate, environmentally acceptable supply of economical and reliable electricity. Its program spans electricity production, delivery and use. Our support is entirely from utilities. Based on over seven years of annually updated analysis of the outlook for energy in the U.S., EPRI remains convinced that electricity is now, and will continue to be, an important growing element in the U.S. energy picture.

In general EPRI emphasizes research and development that will result in near and intermediate term benefits. For example, almost seventy percent of the EPRI effort is focused on projects that should result in benefits to the utilities and their customers during the next ten years. Emphasis is placed on achieving improvements in the performance and availability of existing systems, conservation, load management and environmental control. Much of our electrical systems research is in this category. Twenty-five percent of our effort is devoted to next generation systems, such as fluidized bed combustion, gasification-combined cysle and the nearer term renewables having significant potential beginning in about 10-20 years. Approximately 5 percent of our work is characterized as having a payoff beyond 20 years. We believe that this approach complements the Federal research and development program which emphasizes longer term developments and more basic research.

EPRI AND FEDERAL R&D COORDINATION

Since its inception, EPRI has worked with the Department of Energy (and its predecessor agencies), the Nuclear Regulatory Commission, the Environmental Protection Agency, and other Federal agencies with energy research and development responsibilities. We have carefully coordinated our programs to assure that they are complementary to each other to avoid duplication and to fulfill the roles appropriate to each of us.

The greatest degree of coordination between Federal programs and EPRI exists on the intermediate term technologies that can be of benefit during the 1990's. In many cases this coordination is accomplished by the joint support of large projects such as pilot plants, development facilities and demonstrations of new technologies. Today we are participating in several joint programs with various federal agencies. Examples of such jointly funded developments are the fuel cell demonstration in New York City, the EXXON Donor Solvent project, and the H-Coal pilot plant program and the Battery Energy Storage Test Facility in New Jersey. Essentially all of these efforts are at key intermediate stages of development and important progress is being made. Thus, any change in the Federal energy R&D program will have a serious impact on our work. Significant delays and loss of partially completed research and development work will undoubtedly occur.

CONTINUING NEED FOR FEDERAL GOVERNMENT SPONSORSHIP OF R&D

At the present time we do not believe that the private sector will be able to pick up the work that is being deleted from the Federal program. The electric utility industry is a financially strained, regulated industry which differs significantly from other energy industries. It is having considerable difficulty undertaking even those investments needed to provide continuing reliable service. Hence, it is not in the position to undertake additional R&D beyond that which is currently underway.

While the industry has continued its strong support of EPRI, it has been necessary to slow the growth of the research program to an essentially fixed constant dollar level. Accommodating such a limitation at the same time that the Federal government has cut back its direct support of electricity-related R&D introduces major budget problems for the Institute.

In addition to the immediate problems associated with maintaining a reasonable rate of progress on important jointly supported research and development projects, we believe a continuing need exists for federal research and development on long range more exploratory technologies. Research and development on technologies such as nuclear fusion, breeder reactor, and superconductivity obviously require federal support.

A second category of research requiring continuing federal support includes high risk developments that cannot logically be completely funded by the private sector. In this case the electric energy industry has some unique characteristics that discourage large investments in research and development. For example, the relationship between benefits and risks, which encourage private sector investments, does not apply to the electric utility industry. Being fragmented and regulated, it cannot undertake high risk research and development projects. Commissions typically do not permit rates of return commensurate with an investment in high risk and costly research and development.

Further, the large industrial suppliers to the electric utility industry are currently also constrained in their ability to support R&D because of declining sales, future uncertainties of the market and difficulty of obtaining sufficient return on the investments to justify the expenditures.

Today I wish to address two specific program areas that are currently coordinated with the Department of Energy activities: Electrical Systems and Storage Technologies.

ELECTRICAL SYSTEMS R&D

Electrical Systems research and development is more critical today than ever before. Utility construction, operating and maintenance costs continue to escalate. Competition for land and capital resources increasingly affect delivery system design. Aesthetic and environmental pressures to place the delivery system underground continue. Future Electrical Systems research will provide the additional technology needed to define right-of-way and line design requirements for utility delivery systems. These technical requirements rest on prudent application of engineering principles, new technology and experience. Electrical Systems research provides sound scientific facts that will form the basis for higher capacity, more efficient, more reliable, yet lower unit cost delivery systems needed in the future.

EPRI electrical systems research is primarily oriented toward short-term hardware developments which generally have a high probability of success. Therefore about 85% of the research support in this area is directed to near-term industry needs that will be used within the next five- to ten-year time period. This emphasis on short-term hardware-oriented developments is based on two factors: (1) It fills a gap that exists in electric utility oriented research in the United States, and (2) an understanding that longer term, higher risk research would be carried out by the Federal Government.

In addition to the EPRI work, research and development is undertaken by the individual utilities and the electrical systems equipment suppliers. Individual utility projects usually concentrate on operational requirements, improvements in efficiency, or cost reduction. These efforts seldom include hardware-oriented research.

Traditionally electrical systems hardware research in the United States has been performed by the electric equipment manufacturers. During the past 10 years, however, these manufacturers have significantly de-emphasized their R&D involving the development of new technologies. In addition, there is a trend for the U.S. equipment manufacturers to be absorbed by foreign corporations. The

R&D is then transferred to the new foreign parent company. These factors have substantially reduced new technological breakthroughs in our industry. If this trend continues, the available laboratories and staffs of qualified personnel will be reduced to a point where necessary R&D would have to be delegated to foreign manufacturers.

We believe that there is a need for Federal participation in electrical systems R&D-oriented research. This role, however, should be concentrated in two areas that would otherwise not receive sufficient attention. These areas are: (1) high risk or long range research that would not be sponsored by private industry, and (2) projects of national value but requiring funding of such magnitude that it could not be recovered by private industry.

Examples in the first category include research on superconducting generators, cryogenic cables and ac and dc transmission above 600-kV. Underground transmission is an example of the second case. Where needed, underground transmission is of great importance but the volume of the business tends to be such that private industry cannot afford an aggressive development program.

In the past, the Electrical Systems Division of EPRI and the Electrical Energy Systems of DOE have had annual budgets of comparable size. The two organizations have enjoyed an excellent working relationship and have developed research programs that were complementary. In this planning process, long-term, high risk projects were funded by DOE. We feel this current division of research is reasonable. If this is not done, it will result in a gap in needed technology development that, at present, EPRI, due to financial constraints, will not be able to absorb.

ENERGY STORAGE RESEARCH

New energy storage technologies are required to better couple energy supply with demand in a wide range of applications: transportation (batteries/flywheels), residential (thermal energy storage), industrial (thermal energy storage/batteries), and electric utility (pumped hydro/compressed air/batteries/superconducting magnets). Energy storage provides the potential to displace oil (and gas) based fuels by coal and uranium, in transportation through the electric vehicle and in electric utilities by using stored base-load energy to meet peak demands.

The most important benefit of energy storage that will accrue to the consumer of electric energy, the electric utility industry, and the country as a whole is the conservation of petroleum or gas: 2-3 million barrels of oil equivalent can be saved per year for every 1000 MW of storage installed. About 100×10^6 barrels per year could be saved in the year 2000 if energy storage systems now being developed become available in time for deployment by electric utilities. Utility energy storage could also have other benefits: environmental effects would be reduced and fewer transmission lines may be required. The costs of electricity would likely be lower since utilities could use storage to utilize lower cost fuels and achieve better utilization of baseload power plants. Finally, the reliability of electric service could be enhanced, especially if networks of small dispersed storage devices, such as batteries, could be deployed on future electric power systems.

Current EPRI Effort

Motivated by these potentially major benefits, EPRI has put in place a comprehensive energy storage program that will expend about $62 million over the 1981-1985 time frame; this program is discussed on pp. 498-509 of the EPRI 1981-1985 R&D Plan, EPRI P-1726-SR. During past years, this EPRI program has been carefully coordinated with the energy storage programs funded by the Department of Energy. In recent months, EPRI and the utility industry have been shifting their project selection and funding strategy to assume more of the near-term, hardware-oriented efforts as DOE has moved toward the funding of the higher risk, longer term activities. For instance, responsibility for the development and verification of new components for pumped hydro is now being assumed by the private sector, and the transition of near-term work in compressed air storage to the private sector is essentially complete. EPRI, also, is assuming a larger role in the evaluation of prototypical battery storage devices.

Need for Continuing Federal Sponsored R&D

Substantial technical progess is required before the full benefits of several of the key energy storage concepts can be achieved. DOE should continue to share in the R&D that is required to reduce the technical risks to acceptable levels and to produce the needed technical advances if energy storage technologies are to be deployed by the private sector.

Earlier in this testimony we provided the broad basis for understanding why federal participation is essential. In energy storage research it is appropriate to expand our comments. Currently, there really is not an existing market for these technologies. These are new technologies entering a new market -- not the simple displacement of an existing product with an improved product, but a new product being used in a new way. For example, the lack of industrial spending on R&D for electric vehicles (and batteries) rests primarily on the fact that there is no well-developed market for electric vehicles and the fact that narrow profit margins make technological shifts a high risk. This argument applies equally to the utility load leveling battery market. Not only is the energy storage battery a new technology, but it is a new application. Electric utilities are not currently using any form of dispersed electrochemical storage or generation. Further, while the potential market is large, both the market is uncertain and the probability of success with any one battery system is low -- typically less than 50%.

For the mechanical storage technologies our earlier arguments regarding the lack of reward for electric utility risk taking apply. Here we also have the problem that these are engineered systems --

not manufactured products -- and it is the end user who must be motivated to take the risk. Further, the lack of benefits being concentrated so that an organization doing the R&D can reap its reward further hampers private sector initiative.

Broad Outline of Needed Federal Program

A significant amount of research is required to bring the storage technologies being developed to their full potential. This point and the need for DOE support can be illustrated by describing the status of two of the high priority research areas.

- Advanced compressed-air energy storage (CAES) concepts offer promise of reducing oil use but further work is required on thermal storage and subsystem integration to reduce the substantial technical risks. Federal support is needed in this area and other, higher-risk/high-payoff aspects of CAES, including specifically the evaluation of aquifers as potentially low cost air storage reservoirs. In selectively supporting these areas of R&D, the Government can take advantage of strong private-sector support of near-term CAES technology which should result in a resolution of the basic turbomachinery issues.

- Batteries offer benefits (such as low emissions, rapid response, high part-load efficiency, and modularity) that go well beyond those of the larger storage technologies. However, load leveling batteries will require another 5-10 years of intensive development and evaluation in representative sizes before they will be ready for commercial deployment. Sodium-sulfur, zinc chloride, and zinc bromide batteries all have shown exciting progress in the past few years. EPRI is funding this area at a $5 million annual rate, and developers are providing about $10 million per year. In our opinion a healthy national program in this area should be funded at about $30 million.

- Advanced batteries and applied electrochemistry support is urgently required from DOE since the private sector has had to shift its support from these areas toward near-term work.

- Key questions concerning reliability, life and system integration of new battery technologies cannot be answered until experimental battery systems of modest size are evaluated in the Battery Energy Storage Test (BEST) Facility. This facility has been funded jointly by DOE, Public Service Electric and Gas and EPRI. EPRI has budgeted $1-2 million for its 1982 participation. To achieve the full potential of the facility the total national funding should be about $3 million per year.

- Finally, more advanced or long range utility storage concepts, which cannot be adequately supported by EPRI, such as superconducting magnets, thermal storage, hydrogen, etc., warrant continued investigation.

- Development of energy storage for use by the consumer of electricity merits special attention also. Here we have the opportunity to directly shift energy use from on-peak oil and gas to off-peak coal and nuclear. This requires, however, extensive development of new materials -- primarily for thermal energy storage. We believe that the support of this basic, long range research area is appropriate for DOE.

In summary, a long history of cooperation has existed between the Federal programs and EPRI on the development of the storage options. We estimate that a healthy national effort in this area would require about $50 million a year. The current EPRI program on storage systems is about $8 million per year and the developers are expending about $20 million per year. We believe that it will be difficult for the private sector to bridge this gap.

CONCLUSION

In conclusion, we wish to stress the following points:

* We believe that a continuing federal role does exist in long term high risk Electric Energy Systems and Energy Storage research. While EPRI concurs with the efforts to increase private sector energy R&D, we are realists in recognizing that increased investments are discouraged by the uncertainty of technical success, the weakness of the market and the long development times. Therefore we cannot foresee rapid increases in industry support for research and development at this time.

- EPRI is working to accommodate its program to the changing direction in federally sponsored energy R&D but our ability to meet this challenge is limited by our essentially fixed budget. Naturally improvements in the financial health of the utilities could do much to allow the industry to accomodate some of the changes that are being contemplated. Such improvements will, however, take time and, hence, adjustments in federal support of R&D should consider the momentum and progress being made in the on-going programs.

Mr. Wolpe. Thank you very much, Dr. Schneider.

Mr. Endahl?

STATEMENT OF LOWELL ENDAHL, DIRECTOR OF RESEARCH, NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION

Mr. Endahl. Thank you, Mr. Chairman and Mr. Lujan. My name is Lowell Endahl. I am manager of energy R. & D. for the National Rural Electric Cooperative Association. We appreciate the opportunity to present the NRECA membership views with regard to the electric energy systems and storage work.

NRECA, as you know, is a national service organization which represents nearly 1,000 rural electric cooperatives over the country that serve in 46 States and 2,100 of the Nation's 3,100 counties. They operate about 40 percent of the distribution line in the Nation which serves about 9 percent of the population.

For that reason, we are particularly interested in the work in the electric energy systems and storage work.

Specifically, we would like to comment on the need for strong Federal support both for funding and for staffing for the electric energy systems and storage programs. We are deeply concerned that the importance of this aspect of Federal research is constantly undervalued, and consequently underfunded.

Now, we understand that much of this work could be phased out entirely and left up to the private sector to pick up the pieces. We think that would be a costly and a terrible mistake because this, more than any other research sponsored by the Department of Energy, has a direct value to the electric utility industry and to the public because of its economic and national security implications.

At the recent NRECA annual meeting which was attended by about 10,000 people, the NRECA membership adopted a series of resolutions on energy issues of concern. I have attached a number of those resolutions for your information.

One resolution in particular—support for Federal energy-related research—relates a concern that speaks to the prevalent but mistaken view that industry is in a position to carry forth and complete the research and development efforts that the Government abandons.

On the contrary, utilities and other segments of the electric industry do not have the capital available to conduct high-cost, high-risk research and development for the benefit of the Nation without Government support.

Utilities over the Nation are facing tremendous financial pressures. They are curtailing all unnecessary expenditures, and they are deferring other costs just to stay in business.

We see, among the rural electric systems, a real desire to participate as full members of the Electric Power Research Institute, and many of our rural electric systems are doing this, but many are financially unable to do so. In some States we are finding that the public service commissions are indicating a greater reluctance to permit research contributions to EPRI to be included in the rate base. Because of limitations of funds, even EPRI has had to curtail or delay some of its planned research.

The important energy research programs at DOE are in danger of being killed in two ways: By drastically reducing or eliminating project funds, and by decimating staff required to manage the programs. The electric energy systems division, which has a superb record of conducting productive research of value to the electric industry, is a good example of what has happened. The threat of a program being zeroed out has demoralized and caused many members of a very competent technical staff to seek more secure employment elsewhere. I understand that there are only about 7 professional technical people remaining on the technical staff of 25 or 30 of 2 or 3 years ago.

We believe that we need a presence—a DOE presence—in the electic industry there on that staff.

The NRECA membership refers to this as a brain drain, and indeed it is. Without consistent and realistic Government support, many promising research efforts may never be brought to a productive conclusion. The scientists and engineers who are knowledgeable in this research will be dispersed, and their expertise in these fields will be lost. Thus, we will lose Federal support for important research efforts at a critical stage that not only means loss of beneficial technology but loss of America's scientific leadership among the nations of the world to countries like Japan where strong Government research funding is considered essential for continued rapid growth both in scientific and industrial productivity.

The NRECA membership resolution specifically cited the Electric Energy systems group as worthy of continued research. I would just like to read that portion of the resolution:

> We urge the administration and the Congress to restore funding (at least equivalent to the fiscal year 1981 level) for the electric energy systems division of DOE. This division has an impressive record of productive research that has been of value to, and compatible with, the electric utility industry. Among projects that need adequate funding are: electric field effects; basic transmission and distribution systems research; superconducting technology application; systems control and analysis; and advanced electric energy or battery storage.

The resolution also identifies energy management and storage technologies, including compressed air, underground pumped hydro and battery storage, small-scale hydro and fuel cell development as priority research which should receive continued funding.

We believe that a realistic budget for electric energy systems and storage is very small in comparison with some other research, but it is important for several reasons. It helps to get the thinkers and innovators going and stimulates industry to shoulder technological advancement that will be beneficial to consumers. A good example of that is the load management work that has been conducted by the EES. That has had an effect of moving the entire industry forward in this area.

Second, it serves as competition by example for the best ideas, and it is useful to spur manufacturers, and I think even our Electric Power Research Intitute, to higher levels of performance.

Finally, Government involvement in research provides the credibility so essential in achieving public acceptance of some kinds of research results. An example of this is the electric field effects research, which if it were conducted exclusively by the utilities, would be likely considered suspect by the public regardless of the quality of the research.

Rural electric systems have a special interest in a number of projects which I have already touched on. One major effort is needed in the development of low-cost integration and storage equipment if solar, wind, and other supplemental energy sources are to be expected to produce utility quality power economically.

We have also gone on record, Mr. Chairman, in support of the storage battery research for utility applications. In particular, we have recommended support for the SBEED project which was to be conducted in your State with Wolverine and Northern Michigan Electric Cooperatives. It now appears that project has been terminated. We would urge this committee to consider reinstatement of that activity.

We are also concerned about the dramatic budget cuts in the area of compressed air energy storage. That program has had an effect on Soyland Power Cooperative. It has contributed significantly to the decision of that G. & T. to construct the first compressed air energy storage plant in the United States. Soyland's commitment to that technology would not have been possible had it not been for DOE's efforts.

We support the work, as I mentioned before, on the electric high-voltage transmission and studies relating to electric field effect. We believe that small-scale hydro research and development efforts also deserve support, particularly in the area of improved economics and reducing cost for prefabricated units, including civil works such as the dams and so on.

Research cannot be turned on and off like a faucet. Somehow we hope that Congress and the administration can find a way to fund programs or projects on a multiyear basis, but with some set provisions to provide the necessary continuity and thrust for the most productive and cost-effective use of research dollars.

To cut off funds for a project just short of productive results is false economy. We believe there are several projects in the electric energy systems and storage area that fall into that category.

We urge this committee to request—and I guess you have requested—a status report of the projects underway and what might be expected from additional funding support for 1, 2, or 3 years.

We have supported superconducting technology. We think that it holds great promise both for generation and for transmission. We understand also that there has been some exceptionally fine progress made in the development of gas-insulated cables which would make it more economical to transport power underground than has been possible in the past.

We think it is important that this utility-oriented umbrella type of program be continued because it has economic and national security implications. Our ability as a Nation to move large amounts of power safely and efficiently over high-voltage transmission lines and conversely to utilize dispersed generation and energy storage effectively in times of emergency is of greater importance today than ever. To wipe out that portion of research that concerns itself with these issues simply cannot be in the national interest.

In addition to the funding, we urge the committee to exercise its oversight responsibilities with respect to DOE organization and the role of electric energy systems research. Electric energy systems is like an orphan child that has been lacking a home. It has over the past several years been bounced from the Office of Coal Research to Conservation, then Solar, then Resource Applications, and back again to Conservation.

We respectfully request that the umbrella electric energy systems R. & D. work be reorganized to report directly to the DOE undersecretary in order that it can be properly and effectively coordinated with all other DOE energy research.

Mr. Chairman, we appreciate this opportunity to present these views.

[The prepared statement of Mr. Endahl follows:]

STATEMENT OF
NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION
to the
ENERGY RESEARCH AND PRODUCTION SUBCOMMITTEE
OF THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
HEARING ON
DOE ELECTRIC SYSTEMS AND ENERGY STORAGE RESEARCH AND DEVELOPMENT
Washington, D.C.
March 25, 1982

Madam Chairman and members of the Committee: My name is Lowell J. Endahl, manager of Energy Research and Technological Development for the National Rural Electric Cooperative Association (NRECA). We appreciate the opportunity to present the NRECA membership views with respect to the U.S. Department of Energy activities in Electric Energy Systems and Energy Storage.

NRECA is the national service organization which represents nearly 1000 non-profit, consumer-owned rural electric systems which deliver electric power to approximately 25 million people in the rural and sparsely populated agricultural areas of 46 states. The small cooperatively-owned electric utilities are located in about 2,600 of the nation's 3,100 counties, and they own and operate more than 40% of the distribution lines in the nation to serve about 9% of the population.

Specifically we would like to comment on the continued need for strong Federal support (funding and staffing) for Electric Energy Systems and Energy Storage research programs. We are deeply concerned that the importance of this aspect of Federal research is constantly undervalued--and consequently underfunded. Now, we understand that much of this work could be phased out entirely--and left to the private sector to pick up the pieces. That would be a costly mistake! It, more than any other research sponsored by the DOE, has direct value to the electric utility industry and to the public because of its economic and national security implications.

At the recent NRECA annual meeting (February 8-10), attended by nearly 10,000 people (mostly directors and managers of rural electric systems), the NRECA membership adopted a series of resolutions on energy issues of concern (resolutions attached).

One resolution in particular, "Support for Federal Energy-Related Research" relates the concern that also was expressed at several regional meetings. This resolution speaks to the prevalent, but mistaken view that industry is in a position to carry forth and complete the research and development efforts that government abandons. On the contrary utilities and other segments of the electric industry do not have the capital available to conduct high cost, high risk research and development for the benefit of the nation--without government support. Following is the NRECA membership resolution adopted February 10, 1982:

Support for Federal Energy-Related Research

America's energy future and economic health are closely dependent upon the degree of the federal government's consistent and aggressive involvement in energy-related research and development.

The rural electric cooperatives are concerned about the prevalent attitude of the Administration, the Congress and the public that the responsibility for investing in, and conducting, energy-related research (including costly, high-risk, short and long-range projects) should be turned over completely to the private sector. There seems to be a general feeling that utilities and other types of industry have capital readily available to conduct such research for the benefit of the nation--without government support.

Rural electric cooperatives are ready and willing to carry their fair share of the burden, and they have been participating in major research efforts by their voluntary contributions to the Electric Power Research Institute (EPRI). But the electric cooperatives and other segments of the utility industry are already shouldering a major financial burden in providing for the energy needs of this nation. The electric utility industry cannot, therefore, afford to make major investment in long-range, high-risk research and development projects which do not offer immediate or even near-term solutions to our energy needs.

Therefore, we urge the Administration and Congress to provide the necessary funding and support to maintain a strong federal energy research and development effort with the goal of achieving more efficient generation, transmission, distribution and utilization of electric power. Federal support and funding is particularly needed in areas of research which are considered high-cost and high-risk, with the ultimate objective of stabilizing energy costs.

A significant concern, however, is that current and planned drastic reductions in federal funding results in the dismantlement of experienced research teams and the subsequent loss of trained personnel so vitally necessary to the continued growth of American industry. The economic loss as a result of this "brain drain", as well as the loss of important projects and research momentum, will give an even greater competitive advantage to other industrial nations--i.e., Japan, West Germany, France--where strong government research funding is considered essential in continuing rapid growth in both scientific and industrial productivity.

It is imperative that the federal government maintain continuity in its energy-related research efforts. Therefore, we respectfully urge the Congress to halt the Administration's destruction of important research programs and to establish a strong Energy Research Administration that will carry out the energy research needs of this nation.

The above resolution expresses a universal concern of electric utilities over the nation. They are facing tremendous financial pressures, and are curtailing all "unnecessary expenditures" and deferring other costs just to stay in business.

We see among the rural electric systems a real desire to participate as full members of the Electric Power Research Institute (and many are full members) but many are financially unable to do so. In some states the public service commissions are indicating a greater unwillingness to permit research contributions to EPRI to be included in the rate base for consumers. Because of limitations of funds, EPRI has had to curtail or delay and reschedule some of its planned research.

Now we see a determined effort by the administration to eliminate an important phase of research apparently with the idea the utility industry will fund it. We believe that utilities have reached the limit in taking on additional financial burdens. And yet, the research that is being managed and conducted by the Electric Energy Systems group is exactly the kind of research that can result in greater efficiencies and future savings for consumers.

Important energy research programs are in danger of being killed in two ways--by drastically reducing or eliminating project funds; and by decimating staff required to manage the programs. The Electric Energy Systems Division, which has had a superb record of conducting productive research of value to the electric industry, is a good example of what has happened. The threat of a program being "zeroed out" has demoralized and caused many members of a very competent technical staff to seek more secure employment elsewhere. Only about seven professional, technical people remain of a technical staff of 25 to 30 employed in the Electric Energy Systems group three years ago.

The NRECA membership resolution refers to this as a "brain drain", and indeed it is. Without consistent and realistic government support, many promising research efforts may never be brought to a productive conclusion. Scientists, and engineers who are knowledgeable in this research will be forever dispersed and their expertise in these fields lost. Thus lack of Federal support for important research efforts at a critical stage means not only a loss of beneficial technology, but the loss of America's scientific leadership among the nations of the world.

Priorities in Federal Energy Related Research

The NRECA membership, through resolution, has specifically cited the Electric Energy Systems group as worthy of continued funding. The resolution on "Priorities in Federal Energy Related Research" states:

"We urge the Administration and Congress to restore funding (at least equivalent to the FY '81 level) for the Electric Energy

Systems Division of DOE. This division has an impressive record of productive research that has been of value to, and compatable with, the electric utility industry. Among projects that need adequate funding are: electric field effects; basic transmission and distribution systems research; superconducting technology application; systems control and analysis; and advanced electric energy (battery) storage."

The resolution also identifies energy management and storage technologies (including compressed air, underground pumped hydro and battery storage), small scale hydro and fuel cell development as priority research which should receive continued funding.

A realistic budget for Electric Energy Systems and Storage (we suggest that it be maintained at the 1981 level) is very small in comparison to other research. But it is important for several reasons:

- It helps get the thinkers and innovators going and stimulates industry to shoulder technological advancement that will be beneficial to consumers. For example, the early load management work of EES has had the effect of moving the industry to consider, develop, and adopt new communication and load management technology in a relatively short period of time.

- It serves as "competition by example" for the best ideas, and is useful to spur manufacturers and even our own Electric Power Research Institute to higher levels of performance.

- Government involvement in research provides the credibility so essential in achieving public acceptance of some kinds of research results. An example is the electric fields effects research, which if conducted exclusively by utilities, likely would be considered suspect by the public. Another example is in the research on interconnection issues relating to the purchase, by utilities, of electricity generated by small power producers.

Electric Energy Systems and Energy Storage

Rural electric systems have a special interest in a number of specific projects that have been managed by the Electric Energy Systems Group.

Since rural electric systems own and operate over 40% of the electric distribution line in the nation and serve in the sparsely settled areas of the country where wind and solar energy systems are likely to be popular, they have a special interest in the research being performed by the Department of Energy in Electric Energy Systems and Energy Storage.

A host of new problems are beginning to surface for rural electric systems as small power producers and cogenerators, with all types of power generating equipment (i.e. wind, solar, biomass and hydro) seek to sell their surplus energy to the cooperative utility. All utilities are required to purchase this energy from the qualifying producer under PURPA Sections 201 and 210. While rural electric systems are willing to purchase this self-generated energy of their members, the problems connected with the integration of small quantities and intermittent sources of energy into the utility grid can be difficult and uneconomical. Resolution of such problems involves development of energy storage, and also research on the technical electrical and safety issues of producing acceptable utility quality power. We are pleased that DOE has instituted and conducted research projects pertinent to the interface and storage/ problems of small power producers, and feel that this work needs to be continued.

A major research effort is needed to develop low-cost integration and storage equipment if solar, wind, and other supplemental energy sources are to be expected to produce utility power economically. We recommend that the Electric Energy Systems budget for System Architecture and Integration work be funded at approximately $8 million, in order that this type of research be expedited and information made available promptly.

We have gone on record in the past supporting storage battery research for utility applications. In particular we have recommended support for the SBEED project which was being conducted in cooperation with Wolverine and Northern Michigan Electric Cooperatives. It now appears that this project has been terminated as a result of budget reductions. We would urge this committee to authorize the reinstatement of this activity in the FY-83 Budget at a level of $15 million. The electric cooperatives involved in this activity do not have the resources to carry out the project in absence of Federal support. We also support the Battery Energy Storage Test (BEST) facility program for advanced battery development and testing.

We are also concerned with dramatic budget cuts planned or implemented in other energy storage activities. Of particular concern is future support for work on Compressed Air Energy Storage (CAES) systems. Past efforts by the Department of Energy have contributed significantly to the decision by Soyland Power Cooperative to construct the first CAES plant in the United States. Soyland's commitment to this technology would not have been possible without the confidence rendered conventional CAES by research conducted by the DOE in past years.

DOE's current activities in CAES are confined to research and development on the behavior of porous rock CAES reservoirs and advanced CAES systems which promise greater fuel savings, higher efficiencies, greater load management flexibility, and significantly improved economics. R&D in these areas is a high risk commitment for private parties because of the lack of a developed market and high R&D investment costs. The confirmation of the stability of porous rock reservoirs for CAES, especially at elevated temperatures, is one of the goals of the planned CAES Field Test at Pittsfield, IL and is essential to future development of CAES in aquifers. Development of second generation CAES systems will be delayed for many years if federal research support is not provided. We, therefore, encourage this committee to continue funding of CAES research at a level of $2 million in FY-83.

NRECA member systems recognize that a great many smaller scale storage systems currently undergoing research and development by DOE will significantly improve the potential of electric load management and affect schedules for future generation capacity additions. Storage for seasonal and diurnal energy demands are recognized to have significant potential for reducing both peak electrical demand and consumption of petroleum. We, therefore, encourage this committee to continue Federally supported research in seasonal and diurnal, thermal and electric storage technologies.

Rural electric systems strongly support the research work underway on Extra High Voltage (EHV) Transmission and studies relating to electric field effects (resolution attached). Recent experiences in acquiring right of way and constructing EHV lines have revealed serious misconceptions, mystique, and fearfulness on the part of the general public as to the electric field effects on vegetation, animals, and even people living near EHV lines. Results of the research work underway are urgently needed.

Small scale hydro research and development efforts also deserve support, particularly in the area of improving economics and reducing costs for prefabricated units including the civil works (dams, etc.). Support for feasibility studies would be useful, as would environmental studies relating to minimum stream flow requirements.

A Consistent Program is Needed

Research programs cannot be turned on and off like a faucet. Somehow Congress and the Administration need to find a way to fund programs or projects on a multi-year basis (but with sunset provisions) to provide the necessary continuity and thrust for the most productive and cost-effective use of research dollars. To cut off funds for a project just short of productive results is false economy. We believe that there are several projects in Electric Energy Systems and Storage that fall into that category, and we urge your committee to request a status report of the projects underway, and what results might be expected from additional funding support for another one, two or three years.

For example, we believe that superconducting technology holds great promise, both for generating power more economically and for moving large blocks of power underground. Massachusetts Institute of Technology (MIT) is involved in this work on the fabrication of a 10 MVA superconducting generator, and we understand that the laboratory is built, and that it would cost almost as much to close down the operation as to complete the project over the next two years or so. Also, we understand that some exceptionally fine progress has been made in the development of gas insulated cables which would make it much more economical to transport power underground than has been possible in the past (although it is still about three times the cost of overhead construction, compared to 30 times the cost ten years ago).

The rural electric cooperatives of this nation realize that the Committee and Congress are trying to hold down excessive expenditures in an attempt to produce a budget with a smaller deficit. We commend you for that. In this statement we have suggested action which would continue important electric energy systems and energy storage activities at funding levels which are less than or equal to that expended in these programs in prior years.

DOE Electric Energy Systems last year (FY 81) managed some $46 million worth of energy research programs which includes energy storage research as well as other important research in electric field effects, bulk power transmission, and the problems related to interconnection of dispersed energy sources. We respectfully request that the DOE Electric Energy Systems research budget be continued at about that level, but no less than $30 million.

It is important that this utility oriented umbrella type of program be continued because it has economic and national security implications. Our ability, as a nation, to move large amounts of power safely and efficiently over high voltage transmission lines; and conversely to utilize dispersed generation and energy storage effectively in times of emergency is of greater importance today than ever. To wipe-out that portion of research that concerns itself with these issues cannot be in the national interest. In addition, there are many economics to be achieved by greater attention to improved, more efficient methods of distribution of electricity.

In addition to funding, we also urge the committee to exercise its oversite responsibilities with respect to DOE organization and the role of electric energy systems research. Electric Energy Systems, like an orphaned child, lacks a home. It has, over the past several years, been bounced from the Office of Coal Research to Conservation, then Solar, then Resource Application, and back to Conservation.

The electric utility role in national security and in the economics of this country is too important to be relegated to secondary status. We respectfully request that the umbrella electric systems R&D work be reorganized to report directly to the DOE Undersecretary in order that it can be properly and effectively coordinated with all other DOE energy research.

We thank you for the opportunity to express these views.

RESOLUTIONS ADOPTED BY THE NRECA MEMBERSHIP

at the NRECA Annual Meeting
in Atlanta, GA, February 10, 1982

Support for Federal Energy Related Research

(reprinted in full on page 2 of testimony)

Priorities in Federal Energy Related Research

To meet America's future energy needs, we must develop every practicable energy source that shows promise of becoming feasible and environmentally acceptable through technological research and development.

We urge the Administration and Congress to restore funding (at least equivalent to the FY '81 level) for the Electric Energy Systems Division of DOE. This division has an impressive record of productive research that has been of value to, and compatable with, the electric utility industry. Among projects that need adequate funding are: electric field effects; basic transmission and distribution systems research; superconducting technology application; systems control and analysis; and advanced electric energy (battery) storage.

Other technologies which show potential for commercialization and which deserve continued or increased funding and support by the federal government include the following:

* Fuel cell commercialization;
* Fast-breeder reactors (including both liquid-metal and gas-cooled);
* Small-scale hydro;
* Geothermal (including co-op initiated projects such as the Raft River Geothermal Project, and other such projects in the Texas/New Mexico area);
* Peat, lignite and coal technologies (including gasification, liquefaction, pressurized fluidized bed combustion, MHD, and research done at the lignite lab in Grand Forks, North Dakota);
* Energy management and storage technologies (including compressed air, underground pumped hydro and battery storage);
* Solar energy systems (including residential heating and cooling, solar thermal, and photovoltaic generation of power); and
* More efficient small - and medium-scale power generation systems which can utilize coal and/or waste products and which can be used in a co-generation mode.

We urge that in development and demonstration of each of these technologies, special recognition and attention be given to their impact on, and compatability with, electric utility systems. We further urge the federal government to coordinate these research efforts with EPRI.

Reduced Dependence on Petroleum Through Research

Continuation of present energy policies that encourage increased oil imports will have a disastrous effect on this nation's economy and living standards. All indications are that imported oil prices will continue to rise.

We believe that this nation must act promptly and decisively to reduce dependence on imported oil; and a major part of that effort should involve an expanded research, development and demonstration (RD&D) and commercialization program.

We believe that emphasis on the following programs is essential to ultimately achieve reduction of dependence on foreign oil:

1. Development and commercialization of acceptable processes to produce synthetic fuels from existing abundant fossil fuels and renewable energy resources;

2. Development and demonstration of electric power production emphasizing economically feasible supplemental/alternative energy resources and improved technology in coal utilization;

3. Establishment of policies to shift from an oil-based economy to an electric economy where abundant coal and nuclear resources can be fully utilized; and

4. Development and commercialization of conservation technologies, more efficient electric appliances and equipment (i.e., energy efficient heat pump water heaters) and electric vehicles which--in many instances--can replace gasoline powered vehicles.

We respectfully urge the President and the Congress to act promptly to establish policies and to fund major RD&D and commercialization programs, as outlined, that can begin to reduce the strangehold that oil-producing nations now have over us. We further urge that rural electric cooperatives, as consumer-owned organizations, be recognized as ideal utilities to implement demonstration and commercialization programs and that the Rural Electrification Administration be given authority and the funding to carry out these programs with the assistance of NRECA.

PREVIOUS RESOLUTIONS RECONFIRMED BY NRECA MEMBERSHIP

at the NRECA Annual Meeting in Atlanta, GA, February 10, 1982

147. EXTRA HIGH VOLTAGE TRANSMISSION LINE RESEARCH—The increased use of extra high voltage (EHV) overhead transmission lines for transmitting electric power by rural electric cooperatives is essential if we are to continue to provide the electric power needs of rural America. Recent experiences in acquiring right of way and constructing such EHV lines have revealed serious misconceptions, mystique, and fearfulness on the part of the general public as to the electric field effects on vegetation, animals, and even people living in close proximity to such EHV lines.

Although such concerns are not supported by scientific evidence, we have an urgent need to provide positive, scientifically demonstrated evidence that there are no significantly adverse effects upon vegetation, animals and people living in close proximity to such EHV lines. NRECA urges the Congress and the appropriate federal agency to adequately fund electric fields research work involving both alternating and direct current overhead EHV lines and disseminate such information to the public. (J-1981)

17. ELECTRIC VEHICLE RESEARCH—A viable electric vehicle would significantly reduce the consumption of non-renewal resources and help to eliminate the major source of air pollution. Research toward developing such a vehicle is now underway, and the successful completion of such efforts could significantly alter the load patterns and requirements of rural electric systems. We support electric vehicle research efforts now underway and urge further involvement and effort by others, including the federal government, to expedite this important development. We also urge that in conjunction with this research studies be undertaken to determine the changes in electric system loads that may result from such a development. (J-1975)

44. SEEKING ENERGY SOLUTIONS THROUGH ELECTRIC POWER RESEARCH INSTITUTE (EPRI)—Spiraling fuel costs, dwindling energy resources, higher costs of basic construction materials and high costs of capital have had serious impact on every rural electric system. As cooperatives we have a moral responsibility and obligation to our consumers to make a significant commitment to research and technological development in an effort to utilize new sources of energy and seek more economical ways to supply consumers' electric power needs at reasonable costs.

To that end NRECA member systems have endorsed the Electric Power Research Institute (EPRI) as a practical way of conducting research together with other segments of the electric utility industry. Since our fundraising efforts began, rural electric systems have invested millions of dollars in support of EPRI research. This is in addition to their commitments in support of the liquid metal fast breeder reactor (LMFBR) demonstration program. These commitments are visible evidence of rural electric response to their challenge.

We therefore urge that each and every rural electric system assume its rightful share in the research burden and opportunities by participating voluntarily in the NRECA-EPRI research fund according to the industry-wide formula.(J-1977)

145. FEDERAL SUPPORT FOR FUEL CELL COMMERCIALIZATION—Rural electric cooperatives have great interest in the development of fuel cell power plants because of significant advantages not found in conventional generating equipment. These characteristics show promise of economic benefits for the consumer, improved service availability, conservation of fuel resources, and a cleaner environment.

Commercialization of fuel cell power generation is so near, yet so far from being achieved. The phosphoric acid fuel cell has been developed to the point of large-scale demonstration at the power plant level. But the continued commercial development of the fuel cell continues to need major federal government financial support.

The next step in establishing commercial viability involves broad exposure in the market environment. The risk of proceeding as a strictly private investment has become unacceptably high, due to the economic climate and changing and unpredictable government involvement in utility decisions.

It is both essential and proper that the federal government assume a significant portion of the financial burden. We urge the Congress through the appropriate federal agency to support a comprehensive integrated program with all segments of the utility industry to provide a basis for commercial fuel cell power plant development for electric utility service. (J-1981)

149. FEDERAL SUPPORT FOR PEAT AS FUEL FOR POWER GENERATION—Rural electric cooperatives have great interest in the development of peat as a viable power plant fuel for use in the United States.

There is more peat available in this country than any other fossil fuel with the exception of coal. Current technology for utilizing peat as a direct burning fuel for power generation has been used in foreign countries but harvesting techniques and peat-fired power generation have not been proved in the United States. The first demonstration facility to hasten the development of this new fuel will be costly since it will be the first of a kind plant in the United States.

The risk associated with the development of these facilities utilizing private investment could result in significant delays in the utilization of this most valuable fuel. Therefore, it is both essential and proper that the federal government assume a significant portion of the financial burden for a large scale demonstration facility.

We urge the Administration with the support of Congress to cooperate with rural electric cooperatives and all other segments of the utility industry in the development and testing of a demonstration power facility utilizing peat as a boiler fuel. (J-1981)

Mr. **Wolpe**. Thank you very much, Mr. Endahl.

Mr. Fink?

STATEMENT OF LESTER H. FINK, INSTITUTE OF ELECTRIC & ELECTRONIC ENGINEERS, INC.

Mr. **Fink**. Mr. Chairman, I also appreciate this opportunity to bring testimony to this group. My name is Lester Fink. I am speaking on behalf of both the Energy Committee and the Research and Development Committees of the Institute of Electric and Electronic Engineers.

As you have requested, I will attempt to summarize remarks rather than present them at length.

Much of the material we would choose to present in testimony has already been presented very ably by Dr. Schneider and Mr. Endahl. Again, rather than repeat that, I will attempt to supplement it.

The Institute has supported, and continues to support, the program of the electric energy systems division. There is one aspect of this work which is fundamental to the current discussion which I think is often overlooked and has rarely been stated.

I would like to make four points as briefly as I can. First, I would like to establish that the basis of this program is indeed long range. Second, it is indeed basic research. Third, it stands alone in significant respects. Finally, it is already having a significant impact.

Let me speak first to the long-range nature of this research program. The utility industry is entering its second century and it is continuing a process of physical evolution. There are two important points to notice. First of all, dimensionality of the systems with which we are dealing is increasing tremendously, almost explosively. We are dealing not with a congeries of local systems, but with something that is approaching indeed a national system which is tightly tied together across most of this continent. This is unlike most industry.

I think you can see that this makes for very complex problems, because the dynamic problems that the industry faces and must deal with, both in design and operation, can no longer be dealt with on a purely local basis. More and more, they have to be dealt with on the basis of impact on whole regions of the country. The dimensionality literally is getting out of hand.

Problems that must be solved by means of available conventional methodologies are becoming so cumbersome that it is becoming virtually impossible to treat them with any desired degree of precision or facility.

Second, not only is the industry increasing rapidly in size, it is also increasing in complexity because of the integration of complex new technologies into the system. The system is already complex, and yet we are talking about developing a congeries of new technologies, which are complex in their own right, yet which must be integrated into the ongoing operation of this already complex system without disturbing its very fragile balance.

If I might present a simple analogy, the system is much more complex than something as simple as a watch. In designing and building a watch, we would not think of designing and building the gears separately and then putting them together and expecting them to work. Yet, we are developing technologies as complex and as poorly understood as some of the new wind technologies, to say nothing of projected technologies such as fusion, and we are expecting to integrate them into this already complex system without looking ahead at the impact on the dynamic characteristics of this system.

We are talking about long-range problems, but more importantly we are talking about very basic problems also, because we are talking about a shift in the basis of engineering analysis of dynamic systems.

For the last third of a millenium almost, ever since the time of Newton, systems have been analyzed from the bottom up. You look at the details. You write equations representing the performance of these basic components of the systems, and the forces, and the constraints acting on them, and then you put them together to integrate an analysis of the behavior of the overall system.

I think you can see the impact of increasing dimensionality on this type of analysis. As I said, it is becoming cumbersome to the point of being impracticable.

There is an alternative approach. It has been in the basic scientific literature but it has never been developed to the extent that this detailed differential approach has been developed. In physics it is represented by Hamiltonian analysis of systems. Instead of starting with the details, you look at the integral characteristics of the system, such as total energy or entropy of the system, consider physical constraints on these integral qualities. From these you write the derived dynamic equations which express the dynamics of the overall system. Instead of working from the bottom up starting with the details, you work from the top down, retaining only those characteristics which are essential to the questions you are asking of the system.

This is a basic shift in the paradigm by which engineering analysis of dynamic systems is conducted. It is in its infancy, but over the next generation or couple of generations, if we are going to be able effectively to handle systems of the complexity with which we are dealing, this alternative approach is going to have to be developed. This is research, I submit, at a very basic level.

Third, the program stands alone in unique aspects. So far as we know, there is no comparable program addressing these basic problems at this basic level.

Dr. Schneider has already testified that EPRI has reached the point where there is very little if any long-range research left in their program.

There is another aspect in which this program stands alone. Mr. Endahl has spoken to the attrition of staff. I would like to point out that the manner in which these research programs have been defined and developed is somewhat unique. For a program with a specific mission such as that of the electric energy systems, it is not very effective to sit back and choose to respond to unsolicited proposals which represent something of a random input into the program. This procedure is followed very effectively by an agency such as the National Science Foundation where they do not have a single mission in mind, but it is not at all effective for a program such as this. On the other hand, it is equally ineffective for a single program to attempt to specify the research that should be done. We need the combined thinking of the best minds in relevant disciplines. One small staff, no matter how able, cannot stake out and define in detail which lines of research should be followed.

The approach taken by the electric energy systems division has rather been to define problem areas as basically as they can in such a manner so as to attract the attention and interest of capable investigators, in order that they then might propose the approaches which seem to them to be the most promising and the most fruitful over the long run. Thus, the program is combining the benefits of their perception of the problem with the benefits of getting the best unfettered thinking of the capable investigators around the country.

I think you can see that such an approach requires a staff having significant qualifications. It requires people who have a basic understanding of the problems involved—of the characteristics of the utility industry. It requires people who understand a wide range of academic disciplines in order that they can describe those problems in the appropriate language. It requires people who will be able to describe those problems without injecting the bias of their own views with regard to desirable research.

We suggest that the assembling of such a staff is a difficult process. It has been a significant achievement of the program. Dispersion of that staff would be a significant loss to the program and to the national interest.

Finally, I suggest that the program has already been having a significant impact. In order to substantiate this, I need point only to the literature in the field of electric power systems over the past year—the year 1981.

I noticed in the transactions of the Institute of Electric and Electronic Engineers, notably the transactions of the Power Engineering Society, but also those of the Control Society, Circuits and Systems Society, and the Systems, Man, and Cybernetics Society, just about 50 papers which credit the program of the electric energy systems division as the source of funding for their work.

Numbers don't always tell the whole story, but I do suggest that this says something significant about the impact this program is having on the direction of research on electric energy systems problems in this country.

I thank you very much for your attention, for the opportunity of presenting this testimony, and I also would be pleased to respond to any questions which you may have.

[Material follows:]

[The biographical sketch and prepared statement of Mr. Fink follows:]

Lester H. Fink

Lester H. Fink received both his B.S. and M.S. degrees in Electrical Engineering from the University of Pennsylvania. He is a Professional Engineer, registered to practice in Pennsylvania and Virginia, is the holder of three U.S. Patents, and has published over 50 papers and research reports.

Mr. Fink is currently President of Systems Engineering for Power, Inc., a high technology consulting and research firm, primarily in the field of power engineering. Before forming Systems Engineering for Power, Inc., Mr. Fink's professional career included twenty-five years with the Philadelphia Electric Company, and five years with the Federal Government.

During his over five years of government service, Mr. Fink was responsible for the definition, development, and management of a national research program in systems science and engineering relevant to problems in the planning, engineering and operating of electric energy systems. This program included work on large-scale system structuring, system reliability and effectiveness analysis, stochastic network and storage usage analysis, emergency operating state control, physically based load modeling, utilization of multiterminal high-voltage d-c systems, stochastic operations scheduling, and dynamic security assessment.

Before entering government service in 1974, Mr. Fink worked more than twenty-three years in the Research Division of the Philadelphia Electric Company. During the period 1964-74 he supervised a group of graduate engineers engaged in research on the modeling and simulation of fossil and nuclear generating plants and of interconnected electric power systems, and himself conducted research on the development of new control structures for such plants and systems. Major projects included development of the control regime for the first of the power industry's second-generation digital automatic system control centers, the development and validation of the industry's most widely used mathematical model of a fossil boiler-turbine-generator unit, and development of the first extensive interconnected system model for generation control studies. A decade earlier, Mr. Fink developed the functional specifications for PECo's Automatic Economic Dispatch System (the industry's first on-line digital system), and also the functional specifications for a training simulation for the prototype high-temperature gas-cooled reactor, Peach Bottom I.

For many years Mr. Fink was also active in research related to the rating and operation of high-voltage underground cable systems, including the thermal resistivity of soils, dynamic behaviour of soil moisture under thermal gradients, and impedance of high-pressure-oil pipe-type systems.

During the period 1961-74 Mr. Fink was also an adjunct professor at Drexel University, developing and teaching courses in electromagnetic field theory, control systems theory, nonlinear control systems, random processes in automatic control, and electric power system dynamics.

Throughout his career, Mr. Fink has been active at the national level in professional society and industry affairs, including the AIEE/IEEE Insulated Conductors Committee and Power System Engineering Committee, the IEEE Automatic Control Society, the ISA Automatic Control System Division (Director 1972-74), the Electric Research Council (Steering Committee for Underground Transmission Research), the Engineering Foundation (Conferences Committee), and the Advisory Committee for the University of Pennsylvania Department of System Engineering (Chairman 1973-74).

Statement on Electric Energy Systems

by Lester H. Fink
on behalf of the
Research and Development and
Energy Committees of the
Institute of Electrical and Electronic Engineers, Inc.

Delivered before the Subcommittee
on Energy Research and Production
House Science and Technology Committee

March 25, 1982

Mr. Chairman, Members of the Subcommittee, my name is Lester H. Fink, and I appear before you today on behalf of the Energy and Research and Development Committees of the Institute of Electrical and Electronics Engineers, Inc. (IEEE). The IEEE is the world's largest technical professional society, with over 215,000 members worldwide, more than 165,000 of whom live and work in the United States.

The IEEE has an official Institute position paper on Electricity in the United States which emphasizes the fundamental importance of energy availability to the welfare and economic health of society, which recommends an increased role for electricity in the nation's energy economy, and which calls for increased support of research and development programs to improve electric power system efficiency and reliability, as well as advanced energy conversion technologies.

The IEEE has consistently supported the Electric Energy Systems program in testimony before Congressional committees having oversight over its budget. We strongly support continuation of that program. Elimination would be regrettable on pragmatic grounds, but more importantly would not accord with stated administration research criteria. Pragmatically speaking, abrupt termination of the program would result in cancellation of valuable ongoing programs, many nearing completion, with minor cost savings but major loss of potential benefits due to omission of final evaluation and publication of results. More importantly, the Electric Energy Systems program is one which, at a modest level of funding, has achieved significant results. Continuing elements of the program meet the announced criteria for government support: long-range, high risk research unlikely to be funded by the private sector. Lack of private sector support occurs not only because of current severe shortages of funds for any needs beyond current critical operating needs, but also because the ultimate benefits will accrue to the industry and the economy at large, with only modest shares to any corporate entity within the industry. The program's major benefits are in the realm of advances in the basic theory of electric energy systems, which will be required for the effective understanding, design, and operation of the complex new structures and functions which are evolving, and in the recruitment and training of young professionals at the post graduate level. The program's achievements to date, documented in the open literature, have already had a significant impact on electric energy systems-related research and even, in some cases, practice, while young professionals who participated in graduate research under the program are already beginning to inject new vigor into university power engineering programs as well the power industry at large.

JUSTIFICATION FOR GOVERNMENT SUPPORT

In supporting the Electric Energy Systems program, it is appropriate first to speak to the need for active support by the federal government, and what its role should be. The appropriateness of an active federal role follows from the facts (i) that the product of the industry involved is crucial to the economic well-being and security of the nation, (ii) that the problems involved are basic in nature with serious long-range consequences if they are not resolved, and also are generic in nature with the benefits of their solution accruing to the industry at-large and the national economy, and (iii) that support for such a research program by the private sector is precluded by a variety of factors.

Let me speak to each of these three issues. The first point will elicit little if any disagreement, so will need little buttressing. Over the past century, modern western economies, including most notably that of this country, have evolved with electric energy serving as the life-blood. Electricity provides 20% of the energy used in industrial, commercial, and domestic applications in the United States, and that fraction is growing. For the most part, no practicable substitute energy source exists. Without a reliable supply of electric energy, our technological economy and our standard of living would retrogress, and our national security would undergo horrible cost escalation, insidious degredation, or both.

The second point is less obvious, but no less important. It is that the evolution of our nation's electric energy systems have carried them to a stage where, as very large-scale, complex systems, they are facing problems different in kind from those with which they have dealt in the past.

Electric energy technology is the outgrowth, and flowering, of scientific discoveries made in the late eighteenth and early nineteenth centuries. Much of the basic electric science was encompassed and codified in the masterful work of James Clerk Maxwell, embodied in an epochal pair of volumes entitled "A Treatise on Electricity and Magnetism" which appeared in 1873. Electric power engineering education is still based solidly on the electromagnetic field equations of Maxwell and on the derivative circuit equations of his contemporary Gustav Kirchhoff. It is not that there have been no advances in electrical science in the last century. Rather, the basic science on which our modern electric technology rests is based solidly on evolutionary developments from its nineteenth century foundation. Today, however, the evolutionary development of electric energy systems has carried them to a stage where, by virtue of increasing dimensionality and increasing complexity, major new problems are emerging which are different in kind from the familiar ones of the past, and which are no longer contained even seminally in the works of Maxwell and his successors.

The problems involved are those dealing with the understanding of very large systems. They include both the analysis and the synthesis of such systems. They can be treated effectively only by the emergent discipline of systems science and engineering, which is just beginning to take shape. The ability of such a new discipline to deal effectively with problems as fundamental, far-reaching, and complex as those with which we are concerned will depend on the extent to which that discipline is nurtured by research carefully conceived and guided.

Support by private industry for research of the type under discussion is precluded by a number of factors. With the exception of the few utilities widely recognized as having a meaningful research program, most utility industry research has been conducted by manufacturers. Manufacturers generally have not supported long-range speculative research, which yields no immediate payback or profit; Most require a return on their research investments within five years or less. Tax structures, foreign government-supported competition, and the growing cost-price squeeze all tend to limit manufacturer research support; such as does exist is directed toward improvement of existing lines of equipment in which they have a heavy investment. Internally supported research on new technologies, or on systems-related, as contrasted with component-based, problems, is virtually non-existent. Utilities' support of research is limited not only by their current financial strait, which is increasingly severe in some regions of the country, but also by regulation and local rate based pressures, and is generally limited to solution of their own immediate problems or support of EPRI. EPRI itself is being forced by regulatory pressures on its member utilities to place increasing emphasis on the solution of near-term problems. Almost since its inception, it has emphasized two major current issues, the increased use of coal and uranium, which have received a dominant and increasing share of its budget.

Research of the type under discussion clearly qualifies for government support. It is:

- Crucial to the national well being
- Basic and generic in nature, with long-term benefits accruing to not only to the utility industry at large, but to other sectors concerned with large-scale systems

- o Research which the utility industry itself is precluded from conducting by a variety of factors.

These characteristics of the Electric Energy Systems Research program are clearly consistent with the Administration's criteria for Federal support.

CHARACTERIZATION OF THE ELECTRIC ENERGY SYSTEMS PROGRAM

The Electric Energy Systems program was established within the Department of Interior in mid-1974 as a research program to address the longer range technical problems of the nation's electric power systems, as systems.

From its inception, it has attempted to take a broadly based, long-range view of electric energy systems technology and its research needs, and to direct its efforts toward development and support of research capabilities and efforts in crucial problem areas unlikely to be widely recognized or supported by private industry. Major foci of the program, subsidiary to this objective, included basic systems engineering theory and applications relevant to perceived electric energy systems needs, high voltage bulk power transmission technology for both alternating current and direct current, and initially also low voltage power distribution technology, an element of the program which has since been phased out.

By virtue of the manner in which it was originally conceived, the program has been unique in fundamental respects. This testimony seeks to explain and emphasize its unique characteristics, since they further justify the program's claims to government support, and since if it were discontinued there would be no program left supporting work of a comparable nature.

During initial formulation of the Electric Energy Systems program, it was realized that deepened understanding of the basic characteristics of electric energy systems, at an abstract mathematical level, would provide a uniquely powerful basis for attacking and resolving problems of the widest variety, whenever they were identified and their importance became apparent. This early premise of the program has been repeatedly substantiated as, repeatedly since then, even preliminary and fragmentary results have yielded unique practical insights into diverse practical problems. It must be emphasized that these benefits relative to specific problems have resulted from research directed, not at those problems, but only at strengthening our basic understanding of systems at the abstract level. It is just because of the fundamental nature of the work that it has been so widely useful.

Thus, the Electric Energy Systems research program is unique, first, in its focus, taking a purposeful, coordinated approach to pursuing answers to the long-range fundamental technical problems of the electric energy industry as a functioning interacting system. This is an important point which I cannot stress strongly enough. Disparate technologies cannot be independently developed, manufactured and connected into this vast complex, even fragile, system, without fundamental scientific understanding of the subtle systems relationships and interactions which govern the overall functioning of the system and determine its viability, to say nothing of its reliability. In this respect, the Electric Energy Systems program, with its focus on the emergent systems-related problems of the nation's power systems, and its bold exploitation of the powerful new discipline of systems engineering, is certainly making a unique contribution to the nation's research effort and to the long-range resolution of fundamental problems important to the health of our economy.

The Electric Energy Systems research program is unique also in its modus operandi, by virtue of the manner in which research projects are defined and chosen for support. Sponsorship of research can be a delicate matter. Deep results yielding significant advances in understanding almost always are achieved only by investigators intellectually captivated by the problems on which they are working, and who are free at each stage of their investigation to pursue the next step toward their problem. This is why the National Science Foundation has been so successful with its program of support for unsolicited proposals. Their role lies not in the choice of research topics, but rather in evaluation of topics which would-be investigators see as challenging and promising. This permissive approach, culling out and supporting the best projects to which individual investigators are most attracted, meets the necessary condition for fruitful research--that the investigator be genuinely and deeply interested in his problem. Productive research requires the bringing to bear on a problem of all relevant (and sometimes apparently irrelevant) experience and knowledge of the investigator, focused on the problem through the lens of his interest, to kindle a spark of new insight which can then be nursed into a flame of new knowledge.

The Electric Energy Systems program has taken a modified approach, neither permissive nor mandatory, and its success has been widely recognized. Its approach has been to devote attention first to identifying important generic problems affecting the nation's electric energy systems, especially emergent problems not yet widely recognized, and then, not specifying research to be conducted on those problems, but rather defining their basic features in terms which are both understandable and challenging to investigators in relevant academic disciplines who might normally have been uninvolved in power system problems. Having provided such definitions of important emergent problems, the program has invited proposals for research on contributions to the resolution of facets of those problems. This has resulted in the funding of groups of projects by investigators in a variety of disciplines, each contributing uniquely and in a complementary fashion to a closely related set of subproblems, each of which in turn was of genuine interest to its investigator.

It is important to note, and this is critical to the strength of the program, that although any one of such projects might in itself be speculative and high-risk, there is a good probability that, taken collectively, some one or more of that group of projects will yield valuable results. Over the past several years, the strength of this strategy has been demonstrated repeatedly. Moreover, because we are dealing with concepts, not with hardware, the cost of pursuing such a strategy is modest.

There are difficulties in such an approach. First, it requires that the program personnel have an unusually deep and mature technical understanding of electric energy systems, of their technical nature, their technical characteristics, their technical evolution, their current and above all their emergent technical problems. Second, it requires that these same personnel have an awareness and appreciation of, and a reasonable ability to speak the language of, a wide range of academic engineering and scientific disciplines which might have contributions to make toward the solution of such problems. Third, it requires that these personnel be able to suppress their personal biases with regard to likely approaches to solutions: the more slanted a problem statement is toward a particular approach to a solution, the less likely it is to stimulate the interest of someone who might contribute a more powerful alternative approach.

I might point out here that the assembling of a staff having such qualifications was quite an achievement, and maintaining its nucleus is important.

A research program with as broad a field of responsibility as has the Electric Energy Systems program would be out-of-place in any agency subdivision whose responsibilities are narrowly defined. From the time it was transferred from the Dept. of Interior into the new Energy Research and Development Administration, it has been placed in non-research oriented portions of its agency, to which its charter and concerns were related only peripherally at best. Because of its broadly based, fundamental nature, it has naturally contributed support to all of these areas, but to none of them exclusively, so that it has always seemed to be misplaced and ill-fitted in any of these agency elements, recurrently being forced to show cause to its own management why it should exist, and surviving only through the strong support of the Congress. It is suggested that its proper mission can only be pursued effectively, with full understanding and support of its management, if it be included in a broadly based element such as, for instance, the Office of Energy Research.

CONCLUSIONS

This testimony has described to you a specific research program which, at a modest level of funding, with little support, has been making a significant contribution to the long-range technological needs of one the nations most vital industries. This program is unique in its focus on fundamental long-range problems of a pervasively systems-related nature, and in its emphasis on powerful generic and wholistic, rather than ad hoc, solutions. It is unique also in its manner of defining research objectives so as to enlist the dedicated involvement of leading research investigations from a wide-range of systems-related backgrounds. Despite its avowedly longe-range focus, the program has already demonstrated its value by virtue of interim results that are already finding use.

If any research program qualifies for support by the Federal government, the one which has been described clearly does so. Yet this program has been successively reduced, year by year, since about 1978, and now faces extinction.

We urge the Congress to restore funding for the Electric Energy Systems program at a level which will enable it to sustain its uniquely formulated and thus far unusually successful research effort, to take immediate action to relocate it under an agency element having a charter accordant with and supportive of these broadly-based, longe-range research concerns, and to look to assurance of qualified staff at an adequate level.

I thank you sincerely for this opportunity to bring you this testimony.

Mr. WOLPE. I thank you very much. The testimony of all the panelists, I think, was quite excellent this morning.

I would like to begin by just eliciting the reaction from the panelists to the rationale that has been offered by the administration—a portion of the rationale—for the elimination of much of the research and development funding. That rationale relates to the perception that the energy crisis is no longer as severe as it was previously, and because of that we can afford to cut back the Federal role in research.

Dr. Schneider, could you react to that suggestion?

Dr. SCHNEIDER. Well, if the question is, "Is the energy program still serious?" I think the answer is "Yes."

It is very clear that there are rather significant problems associated with electric energy technology in the areas that we talked about today. The only way to attack those questions is through continued R. & D.

Mr. WOLPE. The argument has been that rising price has generated such a vast increase in energy efficiency that we no longer need a Federal role in that respect.

Dr. SCHNEIDER. Price certainly does provide a very strong signal to the consumer, but what I would prefer to focus on is not arguing whether or not price alone is adequate to provide a signal, but rather whether or not the price signal provides the technical alternatives that are needed to really resolve the issue.

In other words, price just tells people to go find another way of doing things, find a more efficient approach to using electricity, a more efficient way of generating it. Price alone does not provide the technical tool that can be used by that customer. Rather, it is the development and marketing of new technologies by the private sector in cooperation with the Federal Government that can provide that tool. It is very clear that the utility industry as a whole is in a sad financial condition. It is a fragmented industry. It does not have the financial wherewithall to provide funds for investment in new technologies beyond what they are already doing. The success in providing technical alternatives that would permit continued progress and improved energy efficiency does depend on finding a mechanism that would permit with the private and Federal sectors to continue the development of energy technologies.

I would like to refer to some of the original points in my testimony of December 8. Not only is the utility industry fragmented, but many of the technologies which we are dealing with here are technologies that will only develop a positive cash flow supplier two decades from now. With the high interest rates which we have experienced, the supplier industry to the utilities is not really being very aggressive in R. & D. The utilities themselves, being in sad financial shape, cannot do much. The programs that are being put in place to improve the financial condition will take time. It is that time that could in the future lead to having an adequate financial base to support sufficient private sector research to resolve these questions. However, it certainly is not there today.

Mr. WOLPE. Would anyone else on the panel care to respond to the query?

Mr. ENDAHL. I would like to make a brief comment. We are all interested in conservation. One of the things that you have to do is to provide the technical background for ways of exercising that conservation.

Now, we still have a lot of inefficiencies in the electric power industry. We are going to have to move large blocks of power around the country in order to meet the needs of the Nation.

We see continued need for research in order to improve the efficiencies in the electric power business. That is done in small increments, to be sure, but a 1-percent increase in efficiency in either transporting or generating electric power will result in tremendous quantities of energy, oil, or whatever, that can be saved.

Mr. FINK. I would like to mention that regardless of the fluctuating level of the severity of the energy crisis, I think there is general agreement that electric energy plays a crucial role to the economic health and well-being of this country. We are talking about long-range research which is necessary to maintain the capability of the industry to handle the problems which are developing within the industry—the technological problems—especially at the systems area.

This really goes beyond the current status of the energy crisis.

Mr. WOLPE. Would any of you be able to comment on what the Japanese are doing with respect to Government involvement in research and development in comparison with American involvement in research and development?

I asked this question because when we examined other elements of the DOE program in other areas, one of the concerns which was advanced to us by private industry was that we are removing ourselves from any kind of a Federal role at the very moment that the governmental research involvement on the part of the governments in other countries such as Japan and West Germany is actually expanding, and that we stand over the longer haul to put ourselves at even further disadvantage vis-a-vis other nations in the international marketplace in these areas.

Dr. SCHNEIDER. This is really a difficult area to respond to because many of the pieces of information that we accumulate regarding the type of international competition in future technology is information that I would describe as largely at the rumor level. It is hard to quantify.

However, I think that we may have an example in the work which we see going on in Japan in pursuit of fuel cell technology. The fuel cell is an area which has been funded out of the electric energy systems division within DOE in that the demonstration proj-ect in New York City is funded from their budget although it also falls in the fossil energy area.

Arnold Fickett can comment on that.

Mr. FICKETT. I might just add that we have seen the Japanese in the fuel cell area move from virtually no program 3 years ago to a very large program subsidized at the rate of about $60 million over the next 3 years already has participated with Fuji Electric for a 30-kilowatt system completely fabricated by the Japanese using Japanese technology on line this year.

They have a 1 megawatt powerplant that is scheduled to be assembled by a team of four manufacturers, Mitsubishi, Toshiba, Hitachi, and Fuji, that will go on line sometime in 1985 or 1986.

We are quite concerned that they are overtaking our domestic fuel cell capability, and perhaps they will surpass us by 1985 or 1986.

I might also add that in the underground pumped hydro area we do have a contract with Hitachi to develop a high head pumped turbine. It was judged by us that Hitachi—the contract is actually with HTI, a 50/50 equity partnership with GE with Hitachi, but it is an Hiatachi pump/turbine—was probably the best in the world for doing this particular job and that falls under our energy storage program.

In the power-conditioning area as in the whole area of DC-to-AC conversion, it is very clear that the Japanese have the manufacturing capability, the quality assurance expertise, and probably the pricing structure to move very aggressively to again overtake us. This is an area where we have—up until now—been comfortably ahead of the Japanese and yet they are very rapidly catching up with us.

These are three examples. I am sorry that I cannot address your question more broadly.

Mr. WOLPE. I think those examples are very helpful.

Mr. Endahl.

Mr. ENDAHL. Except for one major manufacturer in this country, I understand that the small-scale hydro equipment—a lot of that is being purchased from Japan and Europe.

Mr. WOLPE. I think it is important as we look at these issues not only to examine them from an ideological point of view, but from the standpoint of what is in fact happening in the national marketplace, or we may well be sacrificing ourselves on the alter of ideological niceties.

In the January-February issue, Dr. Schneider, of the EPRI Journal, an article appeared on the quality of power required for connecting solar systems to the grid.

Mr. Tribble indicated that equipment is already available for that purpose. Is it available in the power sizes that are needed?

Dr. SCHNEIDER. I guess that my answer would be that the technology exists, but it is not something that is really available on the market that would deliver the quality of power that you would want to see coming from these small dispersed sources when you get a significant amount of them on the system.

In addition, I would like to point out that the type of technology we are talking about in power-conditioning for PV arrays or for windmills or for batteries fuel cells is very similar to the type of technology that we would be looking at for variable-speed motor drive, and other applications in industry. There, too, the basic problems of the quality of power associated with those technologies is a significant technical issue that is not being adequately addressed today. It is within the Federal programs only adequately addressed within EES.

That article in the Journal does describe that in some detail. I believe that we would be willing to submit that as supplemental testimony, if you would like.

Mr. WOLPE. We would appreciate it if you would.

[The article follows:]

New Connections for New Technologies

A Reprint
January/February 1982

ELECTRIC POWER RESEARCH INSTITUTE
EPRI JOURNAL

Integrating New Sources Into Utility Systems

The decade of the 1980s seems destined to deliver on a promise of the 1970s: the appearance of unconventional, relatively small-scale, dispersed electricity generation. A 4.8-MW fuel cell power plant being started up in New York City may be the forerunner of 10-MW systems that will begin to see utility service within the decade. A major test facility in New Jersey is preparing to try out new battery energy storage systems that may become commercially available by the end of the 1980s. Many utilities are encouraging the installation of megawatt-size cogeneration facilities. Generation from small hydroelectric installations and wind turbines is attracting growing interest. Further ahead, perhaps in the 1990s, photovoltaic generation may become a reality. Even as some of these new technologies are being developed, utilities are anticipating their contribution to electricity networks. Southern California Edison Co., for example, is planning to add up to 2000 MW to its capacity by 1990 through a combination of wind, hydro, cogeneration, fuel cell, geothermal, and solar power. The New England Electric System expects to derive about one billion (10^9) kWh a year by 2000 from small wood, wind, solid waste, hydro, and cogeneration plants. Plainly, power generation on the megawatt scale and smaller will soon be seen on utility networks.

One fundamental difference between these new electricity sources and conventional power plants is that the new sources will be sited in multiple dispersed locations. This raises new questions for utilities accustomed to operating large central power stations. How should these new sources supply electricity to the user? Should each of these sources serve a limited number of users directly, or should they be connected to the electricity network? If megawatt-scale and smaller sources are to become part of electric utilities, what technical and institutional issues must be resolved to pave the way for their integration into gigawatt-scale electricity networks?

One important question—whether electricity sources should stand alone or be connected to the network—has already been answered by the results of several economic and system studies. Wherever a suitable electricity network exists in an area, it is advantageous to connect new energy sources to the network. Only in this way can a reliable supply of power be ensured without expensive backup power generation or energy storage. Equally important, network connection allows a large number of users to share the output from the new sources, guaranteeing fullest use.

This month's cover story discusses how a diverse group of new electricity sources can be integrated cost-effectively and safely into electric utility networks. Some of the integration issues are primarily technical. For fuel cells, storage batteries, and photovoltaic arrays, utilities will need a technology that can convert direct current efficiently and economically to utility-quality alternating current and do so on a relatively small scale. Much has been accomplished in this area during the past 10 years. For alternating current wind and hydro generation, the issue is more how utilities should allow for predictable and unpredictable fluctuations in the power output of these sources on their networks. Considerable progress has been made here, too.

There are several other significant issues to be considered in the introduction of all these new sources of electricity; prominent among them are safety, ownership, and financing. Although safety presents some novel considerations, we can be reasonably certain that application of modern communications and control techniques will permit dispersed power sources to be started, operated, and shut down safely when necessary. But private financing and ownership, feasible because of the relatively small size of projects and attractive because of possible tax credits, can present utilities with a dilemma. Many utilities will welcome some relief from making investments in generating capacity. Other utilities will find that current laws, particularly PURPA, could force them to buy privately generated power at relatively high cost. Strict application of PURPA would tend to give private generators all the benefits of network integration but could leave utilities with most of the risks of privately operated, small new sources of electricity, such as potentially inadequate control and reliability. It seems only fair that the economic benefits from new sources should be shared whenever utilities provide private generators with the economically decisive benefits of integration: a backup power supply, which eliminates the need for costly on-site redundancy and/or storage, and an energy sink, which maximizes the use of private generating equipment (and hence its profits).

Although several issues remain to be resolved, it is apparent that small dispersed sources of electricity are converging on utility systems. As utilities install these sources themselves or accept the electricity from privately owned sources, we are reminded of the days when utility systems were made up of small local generators. In the decades since then, utilities have built the efficient and economic networks that we now depend on. And today these networks permit the most economic use of small new sources. Rather than the sometimes-predicted competition between large and small, hard and soft technologies, we will be seeing a true synthesis for the benefit of both the suppliers and the users of electric power.

Fritz R. Kalhammer

Fritz R. Kalhammer, Director
Energy Management and Utilization Division

New Connections for New Technologies

DC
BATTERY
DC
AC
POWER CONDITIONER

New energy technologies are fast converging on utility electricity networks, but these networks are designed for ac power from large central power plants. Research is needed in dc-to-ac power conditioning, appropriate generation planning, revised operation and control strategies, and institutional issues before technologies such as fuel cells, storage batteries, photovoltaic arrays, and wind turbines can produce electricity for customers.

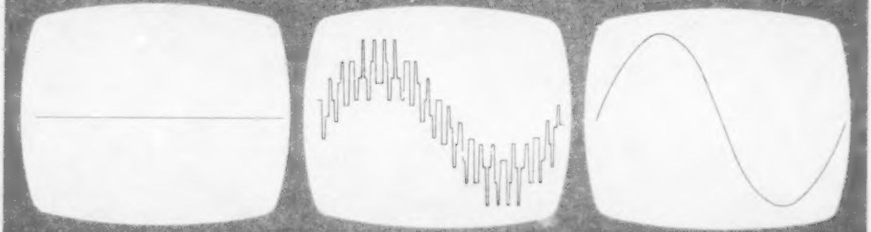
When fuel cells, storage batteries, photovoltaic arrays, and wind turbines begin to come on-line later this decade, a new electricity will be in town. Fuel cells, batteries, photovoltaic arrays, and many small wind turbines will produce direct current (dc) electricity, not the alternating current (ac) that utility systems and customer appliances are designed for. Solar and wind are intermittent and cannot be summoned by stoking a coal boiler or firing a gas turbine. Many of the new technologies will generate power from small dispersed plants instead of from large central power stations. Some of the plants may even be privately owned, and the electricity they produce sold to utilities. In short, these new energy technologies will be different in important ways from the coal, oil, gas, and nuclear technologies that preceded them. If these new technologies are to provide electricity in the future, plans for their integration into the existing utility network have to be made now.

Until recently, the integration of new energy technologies into the existing network was of little concern to utilities. The new technologies had to be developed first; integration issues—and some planners were not convinced there were any—could be resolved later. But new technologies are approaching commercialization, and many integration questions remain unresolved. Ralph Ferraro, technical manager for electric interface and control systems in EPRI's Energy Management and Utilization Division, is particularly concerned that utilities begin to think in terms of total energy delivery systems as they prepare for these new technologies. For total energy delivery, utilities must consider not only new power-generation technologies but also technologies to convert raw dc output to usable ac; planning methodologies to incorporate new technologies into future generation systems; operation and control strategies appropriate for dispersed generation; and answers to perplexing institutional questions.

Shaping dc power

A critical aspect of total energy delivery is the conversion into usable ac power of the dc power that fuel cells, batteries, photovoltaic cells, and many small wind turbines produce. Conversion is absolutely necessary because the nation's electricity systems are based on ac power. Customer equipment—refrigerators, washing machines, air conditioners, water heaters, hair dryers, power tools—uses only ac.

Inverters and converters that can



If power conditioning could be viewed through an oscilloscope, the process would look something like this. The dc electricity (left) is the raw output of fuel cells, storage batteries, photovoltaic arrays, and many small wind turbines. Inside advanced power-conditioning systems, thyristors are switched off and on to approximate an ac waveform (center). The electricity is then further refined to the ac form (right) that utility systems and customer appliances are designed for.

LINE on H.T.

switch dc power to ac are available from manufacturers today, but they are not the equipment that utilities will be buying for the technologies of the impending future. Some of these off-the-shelf inverters and converters are relatively unsophisticated rotating equipment, whose moving parts, high maintenance requirements, short service life, and low efficiencies have a diminishing place in the utility network. Other inverters and converters are modern solid-state equipment, but even they may not be ideal for utility service. They can produce ac electricity warped by harmonics, generate electromagnetic interference, and cause other electrical distortions. All this, in turn, can consume useful power, interfere with proper functioning of the electricity grid (especially power line communications systems), and even damage customer equipment.

More advanced equipment, known as power conditioning systems (PCSs), could go beyond rudimentary dc-to-ac conversion and revamp the resultant ac waves into the power required by utilities and their customers. Such PCSs are now used for high-voltage dc (HVDC) transmission and for uninterruptible dc power sources (such as battery or diesel-powered generators that keep computers at banks, airports, and military installations operating during power outages). But HVDC PCSs are designed to handle power in the range of 100–600 kV at 500–2000 MW, and uninterruptible power sources are designed for a mere 250–500 V at 100 kW. Neither of these approaches is technically or economically suited for the problem of connecting, say, a 3–4-kV, 10-MW fuel cell plant with the electric network.

Utilities will need entirely new PCS designs for new technologies. Unfortunately, the understanding of power quality now on utility lines is so sketchy, and the new technologies are so novel, that performance specifications for PCSs are ill-defined. Yet Ferraro emphasizes that at least interim guidelines for PCSs need to be developed now so that researchers, developers, and manufacturers can have a target for designing and building early systems.

Efforts by EPRI and DOE to develop PCS specifications, designs, and hardware have been under way since the early 1970s. The attempts were first directed at fuel cells and then batteries. EPRI financed a number of PCS design studies to identify technical issues. Later, a study by Westinghouse Electric Corp. summarized the state of the art of inverters and converters and concluded that further work would have to be done to improve PCS efficiencies and lower PCS costs. Not long after, United Technologies Corp. was selected to develop an improved design for an ac/dc power converter for use with both fuel cells and batteries.

While specifications and designs for the PCSs of the future were being developed, early PCS hardware was being built for use at key test facilities. A PCS was built in 1976 for a 1-MW fuel cell test plant funded by United Technologies and nine utilities. Later, a PCS was constructed for the EPRI–DOE 4.8-MW fuel cell demonstration on the grid of Consolidated Edison Co. of New York, Inc. The latter equipment, which incorporates some of the earlier concepts reported in EPRI and DOE studies, is now undergoing startup testing.

A 2.5-MW PCS built by AiResearch Manufacturing Co. of California serves the Battery Energy Storage Test (BEST) Facility, Hillsborough Township, New Jersey, and a 3.5-MW PCS built by Westinghouse was installed at the magnetohydrodynamics (MHD) development facility in Butte, Montana. (EPRI, DOE, and New Jersey's Public Service Electric and Gas Co. built and are now operating the BEST Facility; DOE built the MHD facility, with The Montana Power Co. as host, and EPRI supplied the PCS.) These facilities are built primarily to test batteries and MHD (another new dc generating source) rather than PCSs, so they use conventional, state-of-the-art PCSs rather than advanced concepts. Nevertheless, they will provide a good data base on PCS needs, and the BEST Facility has provisions to test advanced PCSs.

Today, EPRI and DOE are cooperating in the design of a 10-MW PCS for fuel cells and batteries that embodies all the improvements that have been developed in recent years: better semiconductors and microprocessors, advanced mechanical packaging and cooling technologies, lower cost, smaller size, and enhanced efficiencies. Many of the research results will be applicable to PCSs for photovoltaics, wind, and even MHD. The results will be useful not only to utilities but also to other PCS users in the residential, industrial, and commercial sectors.

Meanwhile, DOE is concluding an extensive program to develop a group of PCS designs for small and medium generation sources. DOE's designs for the 5–10-kW range can link small residential generation sources to the utility network; designs for the 150–200-kW range are for intermediate industrial and commercial generation sources. These designs are for photovoltaic systems, but the results may be applied to small wind, fuel cell, and battery storage installations as well. (EPRI has worked with DOE in an advisory capacity on this project.) Several prototype PCSs for residential photovoltaic systems will probably be built over the coming year.

PCS requirements

PCSs are complicated solid-state equipment, and a considerable amount of further research will have to be done to identify PCS specifications and then design systems that meet those specifications. One critical requirement is an acceptably low level of harmonic currents. The preferred waveform for utility and customer equipment is smooth, sinusoidal 60-Hz ac (i.e., the ac makes 60 complete sine-shaped cycles per second). However, power conversion equipment sometimes produces a waveform that includes multiples of 60 cycles—for example, 180, 300, or 420 cycles. These multiples are called harmonics; harmonic currents cause harmonic voltages, and when they clash with utility distribution voltages, jagged waveforms are produced. Excessive harmonic voltages can cause increased electrical losses as well as overheating in utility and customer equipment such as motors, transformers, switchgear, and fuses. The electrical losses cost money, and the overheating can shorten equipment life. Excessive harmonics can also interfere with dispatch control, protection systems, and metering. Because reliable data on the effects of low-quality power are lacking, EPRI is now reviewing existing power-quality data and is considering a more definitive study in that area.

PCSs can be built to suppress harmonics, but unfortunately, present methods focus on specific harmonics. For example, filters made up of inductors and capacitors to eliminate irregular harmonic currents must be fine-tuned to nullify a specific harmonic. If the harmonic is constantly fluctuating, as it might be on a utility line, the cost of the filter increases, as does its size and weight. Another technique for eliminating unwanted harmonics introduces electric phase shifts that effectively cancel harmonic waves. The phase shifts are formed with the help of specially designed transformers, and, like filters, this is a very specific and costly solution.

A more general, and hence less expensive, solution to harmonics may be wave-shaping. Unlike filters or special cancellation transformers, which correct an existing undesirable harmonic, wave-shaping is the exacting electronic construction of desirable waveforms within the power conditioner. This reduces the need for costly, heavy capacitors and special transformers and eliminates the need to make special adjustments at each site. As part of its design project on the 10-MW PCS, EPRI has commissioned construction of prototype hardware to verify the wave-shaping concept.

Another requirement for PCSs is that they must not generate excessive electromagnetic interference (EMI). EMI is actually high-frequency harmonics produced by using high-speed switching devices, such as thyristors, in the conversion from dc to ac power. EMI can interfere with telephone, television, and radio transmissions, and it also has the potential to limit future applications of the utility communications and control equipment that is being developed for load management.

EMI generation is a problem not only with PCSs but also with calculators, microwave ovens, CB radios, and other electronic equipment, and the Federal Communications Commission has issued EMI standards that include standards for PCSs. But as increasing amounts of electronic equipment that use semiconductor switching are plugged into utility lines, the potential EMI problems increase. Thus, the most effective way of dealing with EMI is to prevent its being generated at the source, and techniques that include wiring, shielding, filtering, and mechanical design are used in some PCS designs to directly suppress the phenomenon.

PCSs for utility service must also have acceptable power factor characteristics to maintain service voltage. Typical utility loads have a power factor that corresponds to a load current that slightly lags behind supply voltage. Because of this lagging current, as well as the series reactance of utility lines, power factor correction capacitors must be incorporated into the distribution system.

With the advent of new dc sources on utility systems, it is possible that improperly designed PCS equipment could consume significant amounts of reactive power. Consequently, a utility might have to install additional correction hardware. Increased line losses could also result from higher reactive current levels, and oversized distribution components might be required to handle additional reactive power. Because of the potential cost and technical impacts of low power factors on the distribution system, power factor correction may have to be included in PCSs.

Still another requirement for utility-compatible PCSs is adequate electrical protection. If ac distribution lines malfunction (through a short circuit, for example), the PCS must be able to shield a dc generating source, such as a storage battery, from that malfunction. Conversely, if the dc source malfunctions, the PCS must protect the ac lines from harm. And if malfunctions arise in the PCS itself, measures must be taken to prevent adverse effects on adjacent dc source and ac lines. This protection must be built into the PCS to protect both utility and customer investments.

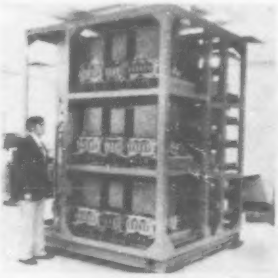
Besides harmonics, EMI, power factor, and protection specifications, PCSs must also meet some more-conventional requirements if they are to serve new technologies effectively. For instance, PCSs must produce ac power efficiently over the wide range of voltage levels at which new technologies will be operated. (The voltages of power generated by fuel cells and storage batteries vary, depending on equipment operating mode. Photovoltaic and wind power voltages also fluctuate, depending on the availability and strength of sunshine and wind.)

Large PCSs must also be modular, rugged, and flexible enough to be sited in a variety of outdoor environments with minimal modification. This will save the cost of redesigning and altering equipment to adapt to changes in altitude, humidity, precipitation, temperature, wind, and airborne pollutants, as well as varying generation, transmission, and distribution parameters. It will also keep manufacturing and maintenance costs down.

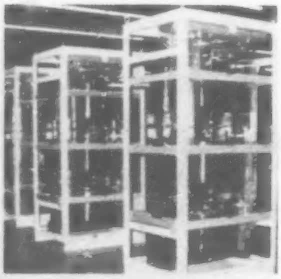
Low cost and long life are basic requirements for PCSs. An early goal was a cost of no more than $88/kW (1980 dollars) for a PCS rated at 10 MW and a life of 20 years, with nominal maintenance and repair. (This selling price assumed production quantities of 150 units a year.) A PCS with recent design improvements is now projected to cost $60–$70/kW; if advances in electronics

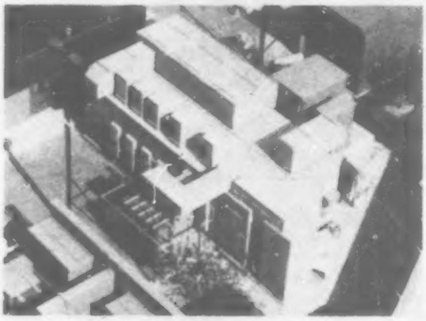
The change from dc to ac power is complicated, and different power-conditioning systems will have to be developed for different technologies. This is how one power-conditioning system, that of the 4.8-MW fuel cell demonstration in New York City, will do it.

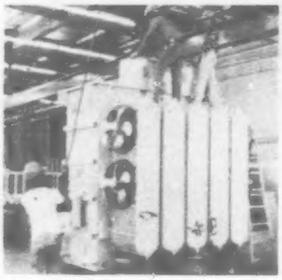
The dc power from fuel cells is first routed through converter bridges, where a rudimentary conversion to ac power takes place.



The ac power next goes through low-voltage series reactors and harmonic cancellation transformers to be shaped to a more desirable waveform.







At the main transformer, the voltage of the outgoing ac power is stepped up to match the voltage on the utility's grid.

Control and diagnostic units oversee the entire conversion process.

continue, the price might drop to about $50/kW by the end of the decade. The small PCSs being developed by DOE for residential and industrial use will have a higher cost: early results indicate that a mass-produced residential-size PCS of 10 kW will cost $180–$300/kW; an industrial-size PCS of about 500 kW will cost $70–$100/kW.

Beyond PCSs

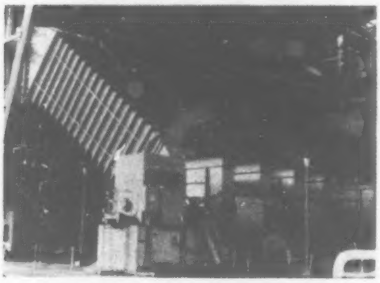
Even superbly designed power conditioning systems cannot provide total energy delivery by themselves. Overall utility planning will have to change to accommodate new technologies, both dc and ac. These planning modifications are just as necessary as PCSs to integrate the new technologies effectively into utility networks.

Utilities typically plan about 10 years ahead for new generating equipment, transmission and distribution equipment, and fuel supply. They use established planning methods for figuring the fuel and capacity contributions (or credits) of coal, oil, gas, and nuclear plants. These conventional plants can be conveniently dispatched as needed, and planning for their availability to generate power is reasonably dependable. Yet some of the new technologies cannot always be marshaled to meet demand. Wind and sun may not be available when power is needed, such as when a photovoltaic system winks out just as early-evening electricity demand picks up. Conversely, wind and sun may be abundant when power is not needed—for example, during periods already adequately served by efficient baseload plants. Wind turbines or photovoltaic arrays are not always the best technologies for these situations.

Because the conventional planning methodologies that work for coal, oil, gas, and nuclear do not take intermittent new resources into account, these will have to be modified to work with sun and wind power. EPRI's Advanced Power Systems Division has developed preliminary ways to estimate both fuel

PCSs FOR TRADITIONAL PLANTS, TOO

Coal, oil, and gas plants may benefit by using power conditioning systems to convert the constant-speed motors that drive plant fans to variable-speed motors.



Fuel cells, storage batteries, photovoltaic arrays, and wind turbines are not the only energy technologies that could benefit from power conditioning systems (PCSs). Coal, oil, and gas plants might also profit from PCSs, used in a different capacity.

To understand the potential benefits, one must first understand a specific area of power plant operation. Air is needed for combustion at coal, oil, and gas plants; this air is forced into boilers by draft fans, which are powered by motors, which in turn may be powered by electricity directly from a plant bus. The voltage to the motor drive system never changes, so the fan's speed is constant. Yet because of plant duty cycles, combustion does not always require the same airflow. A system of dampers throttles the airflow from the fan to match plant load.

The catch is that these 5000–10,000 horsepower draft fans gobble up about 5–10 MW of the plant's electricity output. If an appropriate PCS could be installed between the power bus and the motor drive to control the speed of the fan, the utility could save perhaps 30–50% of the energy that the fan systems currently use.

To prove it, EPRI has recently commissioned UTC and Bechtel Power Corp. to evaluate a PCS retrofit design for constant-speed fans at a Southern California Edison Co. plant. Because PCSs for the utility industry are still under development, the evaluation will use a prototype PCS designed for fuel cells and batteries. The contractors will compare the capital and operating costs of the variable-speed motor drive with those of the constant-speed motor drive already in the plant. Application of the variable-speed drive to a new plant will also be considered. The study will be completed this spring.

Of course, all plants have different cycling characteristics, so the economics of a variable-speed motor drive will vary from plant to plant. But Ralph Ferraro strongly suspects that a variable-speed drive in the right plant could save a utility enough money to pay for the PCS in just a few years. There may be savings not only in electricity but also in wear and tear on auxiliary plant equipment. Should the study confirm Ferraro's suspicions, EPRI may consider demonstrating the design on an existing power plant.

Ferraro cautions that the EPRI study will only give early indications of potential savings because PCSs for utility applications still have a long way to go. But if this PCS strategy works, fossil fuel plants can be saving electricity while developers learn more about PCSs for new technologies. Both today's and tomorrow's power plants come out ahead. □

and capacity credits for wind and photovoltaics; these procedures are based on generation planning techniques readily available to utilities. Ways of estimating transmission and distribution credits have also been established.

The methodologies have been applied on a number of utility systems. In most cases, wind turbines were found to be unlikely candidates for capacity credits; the source is too intermittent for utilities to rely on for firm load-carrying capability. Nevertheless, wind has the potential to displace significant amounts of fuel for a utility, which may make it particularly valuable in areas where wind would replace oil-fired generation. The potential effects of dispersed wind turbines on transmission and distribution (such as a reduction in power losses) were found to be negligible. Use of the photovoltaic methodologies turned up much the same result: capacity credits were unlikely; fuel credits were more likely, but very utility-dependent; transmission and distribution credits were insignificant.

The EPRI methodologies for wind and photovoltaics have been available to utilities for about three years now for use in determining whether photovoltaics or wind might be feasible on a particular network. Utilities can use these methods to calculate a statistical capacity credit from utility system reliability studies. Nevertheless, extensive operating experience with these new sources will be required before the calculated credits can be verified.

Besides altering some of their forward planning, utilities may also have to alter day-to-day systems operation and control if they are to use these new technologies. Current operation and control systems are designed for the generation and transmission of large blocks of power from central power plants; control of subtransmission and distribution is largely decentralized and automatic. Fuel cells, batteries, and other new technologies will be more likely to generate smaller amounts of power from local plants dispersed throughout utility distribution networks, and utilities will have to rethink systems operation and control accordingly. The issues of operation and control become even more complicated in situations where dispersed generation is privately owned, and when surplus power is sold to utilities by the private owners.

Broader concerns

Total energy delivery systems for new technologies will not be complete without attention to institutional concerns. These go beyond the jurisdiction of the utilities and may prove to be the most difficult aspect of total energy delivery simply because they involve so many groups and individuals.

One important institutional issue that must be resolved before new technologies can appear in electricity networks is safety and liability. Although utilities are now generally responsible for accidents and property damage that occur on their systems, they are also in total control of those systems: when a storm knocks down a distribution line, the utility can shut off power to the line, and repairmen and bystanders can be reasonably safe as they go about their business. But when dispersed generation comes along, possibly owned by private individuals or organizations, responsibilities become muddled. A private individual may use utility lines under applicable PURPA regulations, but this generation is not under utility control. If a storm downs a distribution line and the local utility shuts off power to the area, the privately owned generation unit may keep on producing power, potentially harming people or equipment. The responsibilities of the utility and the private generator must be more clearly designated; contracts for liability must be drawn up, and insurance requirements must be established to accommodate the new situation.

Problems could also appear in the area of metering and billing. Utilities now do all electricity metering and billing because they provide all the power their customers use. When private individuals begin to produce their own power and sell the surplus to utilities, an entirely new system of metering and billing will have to be established. Responsibilities and costs for such a system have yet to be specified.

Another difficult institutional issue concerns power standards. Measures of power quality have not been sharply defined, but before individuals begin to sell power to utilities and other parties, standards must be set and enforced. This will ensure that a specific level of power quality is maintained and that utility and customer equipment is not damaged by lower-quality power.

Still other institutional questions stand unanswered. Land use is a potentially troublesome question, because some new technologies, such as wind and photovoltaics, are site-dependent for success, and suitable sites may be coveted by other interest groups. Subtle environmental effects are also a question mark, for while coal, oil, gas, and nuclear have been around long enough to build up data on their environmental effects, the possible impacts of new technologies may take years to be identified and then corrected.

New technologies may seem to be complete systems that will stand by themselves, generating electricity imperturbably regardless of the rest of the utility system. "But these systems are really only subsystems, pieces of a larger system," concludes Ferraro. With power conditioners, with new generation planning techniques, with revised operation and control systems, and with answers to institutional issues, the electricity from new energy technologies can be delivered successfully to utility customers. ■

This article was written by Nadine Lihach. Technical background information was provided by Ralph Ferraro, Energy Management and Utilization Division.

Mr. WOLPE. Mr. Lujan?

Mr. LUJAN. Thank you, Mr. Chairman.

We all serve on various committees, and as we sit on each committee, we have a constituency for a particular program that comes to us. The chairman mentioned that the rationale for cutting down is that the energy crisis is over and therefore we can relax.

I do not see the rationale as being that. I see the rationale as being that we have a host of things that we have to fund. Some of us think that there is a limited amount in the pot to fund them with. Which of the things are you going to do, and who is going to pick what we do not fund?

I am a little disturbed that all of you point to the sad state of the utilities as just barely getting along and unable to pick up where the Government leaves off.

However, recently the apartment where I live went condominium. My wife said that was where we were going to live so I had no choice. I had to buy it. I looked around at what I might sell. I had some utility stocks. I thought that they had gone about as high as they can. It was the Public Service Co. of New Mexico and it was at 23⅞, and the highest it had ever been was 24. I thought, "Well, it is at the very top. Those are the ones that I will pick."

I opened up the paper yesterday, and I was mistaken. It has gone even further than that. It never before had gone above the $24-a-share mark, but now it has. I am also disturbed because it is the stock that I had which paid me the highest dividend percentage wise.

Beyond that, they have gone into a diversification program, as a lot of utilities have. It seems to me like the utilities are not in the dire circumstances which you gentlemen talk about.

I think that they had just become used to the Government's picking up the tab and they don't have to. That is why they can pay good dividends. That is why their stock goes up, and that is why they are able to take some of their money and diversify into industries other than the energy business.

Is the utility business in such dire straits as you are talking about, or have they just not been willing to do it because Uncle Sam was going to pick up the tab?

Just like the Japanese now, I am sure that they are going to put all kinds of money into research, but we are picking up their marbles in the defense area. We have got ourselves into the situation where we are the protectors of the entire world, so that is exactly what has happened and why all these countries have gotten way ahead of us.

Maybe that is not a question, but perhaps it is a prod, Dr. Schneider, to go back to the utilities and say, "Hey, you guys, you know, you are not in such bad shape. You should pick up some of these costs."

Yes, Mr. Endahl?

Mr. ENDAHL. Mr. Lujan, speaking for the Rural Electric Cooperative as a nonprofit organization, we have to recognize that anything that is funded by a utility must come from the consumer. The consumer has to pay for it regardless of how it is done. Now, we have a choice——

Mr. LUJAN. Through their rate or through their taxes.

Mr. **Endahl**. Now, we have a choice. Do we want electric rates to continue to skyrocket? Is that in the national interest, or do we want to do it through some other means?

Mr. **Lujan**. Well, it is the same thing we face: pay either through the local government or the Federal Government.

What you are saying is, "you, Mr. Wolpe and Mr. Lujan raise the taxes so that we can pay for this research because I don't want to raise the rates to pay for the research."

Mr. **Endahl**. But some of our rural electric systems are regulated and all of the invester owned utilities are regulated.

Mr. **Lujan**. But they are guaranteed a certain percent.

Mr. **Endahl**. But the State commissions are becoming less and less willing to permit the research funds to be passed through to the ratepayers. Therefore, we are caught in the squeeze. We cannot raise the rates, and we cannot provide the funding that is necessary for the research.

Mr. **Lujan**. We cannot raise the taxes, either. That is the problem here.

You know, one other thing—we talk about research, and there are a lot of things that go into a good, efficient system. On the uranium enrichment process, we buy a lot of electricity from TVA that we cannot use, and the bill, if we don't use it, is going to be $150 million that we have to pay them. If we do use it, it is going to be $500 million. In the hearings, we were saying:

> Well, why don't you ship it on to somebody else? GPU, for example, needs low-cost power, and the electricity is available there. The capability is available.

They say:

> Well, because of the different laws, because of noncooperation by the neighboring utilities, we cannot really deliver that power from TVA up to the service area that is serviced by GPU.

What good is all this technology if we have all those institutional barriers? It seems like a good area that we might want to get into.

Would you like to comment on that Dr. Schneider?

Dr. **Schneider**. I am not really anxious to get into that, nor am I particularly anxious to get into the previous question. [Laughter.]

Let me—my background and my degree is in physics. My living is based on trying to do——

Mr. **Lujan**. Mine is in business administration.

Dr. **Schneider**. You know, my living is based on trying to do a good job in managing advanced technology development projects.

The first question should be addressed perhaps to the stockbrokers in New York. Just from my own personal experience I see the book value of the bulk of the utility stocks at being about 75 percent. The bond ratings have dropped in many cases from triple A down to A and high B. That, to me, reflects a very substantial negative change in the financial position of the utilities.

The reason why you get such high dividends on utility stocks is because they have to pay high dividends in order to attract the people to buy the stock.

The issue on rate-of-return in the utility industry is broken down into three sections: the public power section, the rural electric, and the investor owned, and some of the rural electrics and all of the investor owned are regulated by State commissions. These commissions do rule on the rate of return that those companies can achieve. In a period of rising prices, the rate of return has typically not been commensurate with a healthy, sound utility industry as reflected by the bond ratings and the book value of the stock.

However, that is, as I said, not my area of expertise.

Mr. LUJAN. Well, the question is: Have we retarded research by the private sector by increasing Government funding all along? There is no incentive.

Dr. SCHNEIDER. Well, let me review——

Mr. LUJAN. Maybe they will invest now.

Dr. SCHNEIDER. Let me review the situation with EPRI. EPRI was conceived and established at the turn of the 1960's into the 1970's. The initial plans and projections of budgets for the Electric Power Research Institute had shown an extremely healthy growth curve during the last 5 years.

It was 5 years ago that I joined EPRI. The first week that I was there was we learned that because of the financial crisis brought on by the extremely high increases in oil prices, the utility industry was not going to be able to meet the growth request represented by our budget.

We then proceeded to do all of our planning exercises over again in about a 3-week period to match a lower growth rate. At the moment, our growth is limited by our ability to attract the voluntary contributions from the companies that support us. Those are voluntary contributions.

Mr. LUJAN. I might say that is a good business practice. You looked at your expenditures in connection with your income. That is exactly what we are doing.

Dr. SCHNEIDER. That is right. However, in this instance I would like to point out that the response that was made earlier about Federal borrowing of money to do R. & D. is in really very much the same situation faced by the utility industry.

Since we are in the private sector, we are responsible to the stockholders or the local public power authority or the co-op customers themselves, we have exactly the same problem that the Federal Government faces. It is a question of two groups in the United States—the Federal sector and the private sector—having to address the same problem.

We have got to cooperatively resolve it and continue the momentum of the technical progress which we have had.

Mr. LUJAN. Let me ask a quick question on the small hydro power. It could be a philosophical argument, and we can go on forever on it.

What is the outlook? Can we look to small-scale hydropower as making a significant contribution?

Mr. ENDAHL. I do not have the exact figures before me, but I believe that we can expect something in the nature of 7,600 megawatts of power from small hydro in this decade if it can be developed. Small-scale hydro, I am sure, is going to be more expensive than other types of hydro. However, as we move along and the energy costs go higher, we think there is some potential there. We would like to see it developed where it can be developed.

Mr. LUJAN. Seven thousand megawatts isn't really that much.

Dr. SCHNEIDER. Well, let me provide a little more detail on that.

In my previous position, I was responsible for starting the hydroelectric program at EPRI which is now representing a funding level of about $2 million. I think that really responds partially to the question on small hydro. Our program is on hydroelectric technology in general, small hydro being only one element of hydroelectric technology.

Currently, we have about 72,000 megawatts of conventional hydroelectric generation, and another 13,000 in pumped storage. That represents approximately 12 percent of U.S. electric energy generation. Therefore, it is a very significant technology. A very large number of those plants are federally owned projects. I would like to point out that the Government's programs in improving hydroelectric technology are largely focused on small hydro. There is very little going on in conventional hydroelectric technology.

Our program is approaching $2 million. In the other areas that we are talking about, EPRI's programs in electrical systems energy storage and hydro represents about $40 million. Therefore, the private sector has a very heavy and significant commitment to these technologies. EPRI is really looking at the partnership that we have had with the Federal Government and asking if the relative funding ratios that are being forecasted for the coming Federal budget are really appropriate.

We are putting our money where we think the development is needed, and we are saying that there is a need for a continuation in these areas of the partnership that I believe has been exceptional with the Federal Government.

Mr. **Lujan**. Thank you.

Mr. Hollenbeck?

Mr. **Hollenbeck**. Yes, sir.

Dr. Schneider, what is going to happen to the BEST facility? I understand that EPRI is going to take over part of that. I wonder if the Public Service Co. possibly will take over the rest? I wonder if you could break that down?

Dr. **Schneider**. Yes; I am sure you are aware that Public Service Electric & Gas, EPRI, and DOE have really cosponsored the BEST facility since its inception. We are presently making provisions to work with Public Service Electric & Gas to continue the sponsorship of the operating phase of that facility beyond 1983 when DOE funding will no longer be available.

It is not completely clear—we were just talking to Public Service Electric & Gas yesterday as a matter of fact to see what allowances they have in their budget to continue a cost sharing or to increase their cost sharing of the BEST facility.

It is not clear what level that will be and exactly how we will proceed. Nevertheless, I think we at EPRI and Public Service are committed to finding the wherewithal to keep the operating phase of that program alive.

There is a second piece of the question, however, and that is how are we going to fund the exploratory battery systems that will have to come to that facility. We are now reaching the time when there are a number of advanced batteries that are at the point where they can merit such evaluations.

However, now that we are shifting some of our money to the more near-term operational phases of the BEST facility, it will be difficult to support and to fund all of the exploratory batteries that we would like to run through the BEST facility in order to do the preliminary testing of those batteries without DOE support.

Mr. HOLLENBECK. Thank you, Mr. Chairman.

Mr. WOLPE. Following up on some of the observations that Mr. Lujan made earlier, I think the issue that is before this committee is not whether or not there shall be reductions in this area of the Department of Energy or in the Department of Energy programs generally. It is clear that there will be reductions in programs right across the board.

The issue that we are confronted with in this Committee, of course, is the allocation of the cuts and the allocation of scarce resources—increasingly scarce resources. That then relates to the question of priority.

I, for one, and I think I probably—in this respect—speak for the committee, do not have the perception reflected in the administration rationale that diminished crisis is upon us and therefore we don't need to have an emphasis in terms of a government role.

However, I am troubled very deeply by the advancement of that rationale to essentially gut those programs which in the view of many represent the greatest potential and the cheapest means of displacing petroleum over the longer haul and moving us toward more efficient energy utilization generally.

I certainly, at least, have to weigh those proposed cuts against $254 million this year for the Clinch River $3 billion project and other types of subsidies that are continuing to flow to some high-tech synfuels projects that I think are just questionable on economic grounds, on dollars and cents grounds, in terms of the displacement of petroleum given the investment that is being proposed.

Your testimony this morning, I think, has been very helpful in laying out the broader dimensions of what is at stake as we look at this question of energy research and development. I want to thank each of you.

I would like at this point to invite Mr. Tribble back to the table.

Mr. Tribble, have you undertaken any kind of analysis of the loss of use of the national laboratories if Federal research programs were to be phased out in your area?

Mr. TRIBBLE. No, we haven't because we don't anticipate that the national laboratories will no longer be available.

Mr. WOLPE. Well, are you contemplating that the 12,000 or so people that are presently employed at the national laboratories in civilian research would continue to be employed in those numbers if the major source of funding for the national laboratories has been eliminated?

Mr. TRIBBLE. Certainly, they will have to suffer some of the reductions that we in DOE are also taking. We would not expect that the labs would continue at their present level of staffing. On the other hand, we would expect that the labs would continue to be in business, they would perhaps do maybe more in-house work than they have been doing, and that would have a leveling influence on the staff levels.

Mr. WOLPE. My understanding is that presently the Federal Government owns over $8 billion worth of some of the finest laboratories in the world for civilian research purposes. I guess the question is that I am surprised to hear that there has been no assessment of the impact of the cuts upon that operation. Is that essentially what is being said?

Mr. **Tribble**. The reductions that we are speaking of here will have a very minor effect on the labs as a whole.

Mr. **Wolpe**. Is there any assessment of the overall reductions——

Mr. **Tribble**. No.

Mr. **Wolpe** [continuing]. In the Department of Energy that any one has—

Mr. **Tribble**. Not insofar as I know. There may very well be. It may have been done by others in the Department of Energy, but we in our office have not.

Mr. **Wolpe**. I want to pursue for a moment this issue of what is basic and therefore appropriate for the Federal Government to assume as basic research, and what would fall into a different kind of category that you think that industry should more properly assume.

Suppose a private firm decided to develop a thermal storage system based on molten salts at their own expense. Would you expect them also to perform all of materials research on perhaps 25 salt variations and do all of the research in materials corrosion as well?

Mr. **Tribble**. I would think that they would have to evaluate that project on the basis of its potential ROI. Before they could enter it into their research categories, they would have to take a look at the potential cost of the overall experiment, taking in all those kinds of considerations, and see if in the long term, the company would benefit.

Mr. **Wolpe**. Do you expect that each private firm would repeat the basic research on the various salts and materials that would be involved in that kind of venture?

Mr. **Tribble**. No, I would not because there has been generally, through the trade associations, a substantial interchange of information except proprietary information whereby if one company does research and comes up with the answer to a question in many instances a paper is presented through the trade association and this information is made available to others.

Mr. **Wolpe**. Are you saying that you really do not think that even basic research in materials is an appropriate role for the Federal Government to undertake?

Mr. **Tribble**. We are going forward with some materials research even in our office. One of the areas that we are working on is high-temperature ceramics. We, as you may know, have more or less reached the limit of metals in their temperature and erosion characteristics in combustion turbines. The next step in improving the efficiency of those machines will be to replace some metal parts with ceramic parts. We are going forward with that work.

Mr. **Wolpe**. How would you differentiate that kind of research from the hypothetical example which I presented a moment ago?

Mr. **Tribble**. In the case of the molten salts, there are companies that are in fact doing this kind of research at this time. In our central test facility at Sandia, one of the companies is testing a molten salt boiler.

Mr. **Wolpe**. That is a Federal research facility, is it not?

Mr. TRIBBLE. It is, but the work is being done there by a private company.

Mr. WOLPE. Under contract?

Mr. TRIBBLE. No. We are permitting them to come in and use the facility to do their research.

Mr. WOLPE. Would you please describe precisely the nature of the relationship between the company and the Government and the contribution of the implicit subsidy of the Government to that research as a consequence of our making that facility available?

Mr. TRIBBLE. Yes. There is no question that we are in fact subsidizing because this facility is very unique. It is perhaps the only facility in the country that is set up so that this kind of an experiment can be run.

Mr. WOLPE. Why should we do that? Why shouldn't the company be forced to undertake that on its own initiative?

Mr. TRIBBLE. This is the kind of activity that we have been engaged in, and we do propose to go forward with it because we think that this——

Mr. WOLPE. The question is why.

Mr. TRIBBLE. Well, because here we feel that we can assist an entire industry to move forward in a relatively small Federal role.

Mr. WOLPE. Let me hasten to add that I am not critical of that decision. I just find it inconsistent with a lot of other decisions that you have made.

Will research continue on compressed gas insulated electric transmission if the Government terminates its R. & D. program in this area?

Mr. TRIBBLE. I do not know of anyone who is going ahead with that. There are very few installations that require that kind of equipment just as there are very few installations that require the superconducting cables.

Mr. WOLPE. My understanding was that this was a rather critical development for underground cable work in cities.

Mr. TRIBBLE. It certainly has application there. This is the place that it will come into use if it does.

Mr. WOLPE. So in other words, your testimony is that you are abandoning this effort, not on the grounds that industry is about to take it up, but you just do not think that it is important.

Mr. TRIBBLE. We do not think that it can pass the cut on priorities. That is right.

Mr. WOLPE. Have you completed a national investigation and analysis which identifies what company is going to work on what projects that you are proposing to abandon? Has that kind of specific analysis been undertaken in advance of your budget recommendations?

Mr. TRIBBLE. No; it has not because we looked at those independent of whether or not they would be taken over. Some of them we really feel will certainly not be taken over, and on the other hand are not valuable for either one of us to be doing it. Therefore, to answer your question, no, we have not done that kind of analysis.

Mr. WOLPE. Which ones are not valuable enough for anyone to be working on? Would you identify those for us now?

Mr. TRIBBLE. Yes. We have dropped homeostatic control which is a very sophisticated theory of computer control of electric power consumption with the final objective of relieving the utility of the need to retain spinning reserve.

We think that the utility industry is so firmly committed to support the spinning-reserve philosophy that they are unlikely to pick this up, and we are unwilling to go forward with it because we do not feel that it is that valuable.

Mr. WOLPE. Do you know of anyone who might pick up that particular project?

Mr. TRIBBLE. No. We contacted a number of utilities, and as a matter of fact, a number of utilities contacted us, and tried to persuade us not to drop it. However, when we asked them if they would be willing to contribute to its continuation financially, they unfortunately could not see their way to do so which indicated that they would not take it up.

Mr. WOLPE. Incidentally—I want you to continue with this list——

Mr. TRIBBLE. Yes.

Mr. WOLPE. But I would also ask if you could provide the committee for the written record with a list of all of the projects that are being dropped, and a list also of which projects where you have identified——

Mr. TRIBBLE. Which category?

Mr. WOLPE [continuing]. Someone who will be picking them up——

Mr. TRIBBLE. Sure.

Mr. WOLPE. And which ones there has been no specific identification of continuation in the private sector.

Mr. TRIBBLE. Yes.

[The information follows:]

We have not carried out such an investigation and analysis. There are approximately 3120 independent utilities of which 271 are investor-owned, supplying about 80 percent of the nation's electricity, and the remainder are publicly-owned (federal, state, municipal and cooperative) utilities. The utilities are authorized to operate as locally regulated monopolies within specified areas and their operations and financial performances are constrained by the interests of their service areas. The interests of the electric utilities geographically cover the entire country; hence, it may be possible that the aggregate of locally constrained interests will form a program which addresses the national research needs of the United States. As stated in my prepared testimony which was submitted to the Subcommittee for the record:

"The greater Federal presence advocated by previous administrations is not a desirable goal. It is our belief that utilities, EPRI, utility equipment manufacturers, and universities will build, over time, on the work formerly sponsored by EES. The cost-sharing contracts that we have had with industry will have been seed money. EPRI and the private sector will now have to choose what work to continue."

Mr. WOLPE. Thank you.

Mr. TRIBBLE. Yes.

Mr. WOLPE. Will you continue, please?

Mr. TRIBBLE. System restoration methods is another one that we are not going forward with. This is the situation that you get into when you have blackout of one or more areas in a grid. The hardware is there. This is a very site-specific and utility-grid-specific question. Anytime you suffer a blackout in any particular area the restoration of that system depends upon the circuit breakers and other equipment that is in the grid that will permit you to isolate areas where the problems are and restore service to the areas where it can be restored and still work on the problem area in safety.

That is so site specific that we feel that we could not justify continuing that.

Mr. **Wolpe**. Maybe I am missing something. Isn't that a pretty basic kind of issue? It is the question of regional blackouts that can occur through regional grid failure.

Mr. **Tribble**. It is certainly a basic——

Mr. **Wolpe**. In other words, isn't that an issue of national significance?

Mr. **Tribble**. Yes; but it is one that does not lend itself to research solution. It is one that lends itself to installation of adequate hardware to limit the blackout in the beginning and to permit quick restoration after it takes place.

The equipment is already available by which most of this kind of thing can be done, by which you can limit the area and also isolate the problem.

Mr. **Wolpe**. Please continue.

Mr. **Tribble**. Another project that we are not going to go ahead with is support of a very sophisticated—what is called a network analyzer—whereby in a grid if a utility is going to increase supply in a particular area, put in a new substation, or build a new transmission system, they need to conduct an analysis of their grid to determine what the current flows will be, what the fault possibilities are, and how they would design the system.

There are these network analyzers available through the private sector. There are some available in the universities. We feel that this is work they certainly have been doing for many years, will continue, and we see no reason why we should be involved in it.

Another one is planning under uncertainty. That is where you really have variables that you do not control. That planning takes place for you to be able to accommodate circumstances that arise from unforeseen factors. All of this seems maybe just beyond my individual capacity, but that is another one in that category.

Mr. **Wolpe**. Now, is that something which you think does not fall in the category of basic research?

Mr. **Tribble**. That is one which we feel just cannot stand the priority cut. We do not feel like we could borrow money and finance that.

I will just quickly name a few of these. Emergency control of power systems, control of very large-scale systems, power-system stability, load-shedding equipment—those are all that come to mind right at the moment.

Mr. **Wolpe**. With respect to those industries which you believe will be assuming some of the work that DOE proposes to abandon, how many written commitments have you received from private industry and the utilities confirming their long-term research plans to take over work formerly funded by the Federal Government?

Mr. **Tribble**. Well, of course, we have not asked for any, and it is unlikely that they would voluntarily provide that. Let me address that question, though, for just a moment. I am sure you are aware of the provisions of the 1981 Tax Act which do provide a substantial Government subsidy for research to be undertaken by the private sector.

We think that this certainly will have its benefits.

Mr. **Wolpe**. I feel a bit like—I cannot resist this question.

Mr. **Tribble**. Go right ahead.

Mr. **Wolpe**. Do you prefer to borrow to pay for a tax cut?

Mr. **Tribble**. Yes. Wait a minute. Wait a minute. Did you say, "Borrow to pay for a tax cut?" Wait a minute. Let me correct my statement. I thought you said, "a tax credit." Are you talking about a cut or a credit?

Mr. **Wolpe**. There is a difference?

Mr. **Tribble**. Yes.

Mr. **Wolpe**. Yes? That is interesting. What is the difference?

Mr. **Tribble**. Because with a tax credit such as is permitted in the 1981 tax law, the companies and the people who have the need to spend money on research or additional planning equipment and take accelerated depreciation are making the choice of where they spend their dollars, and that choice will be much better made by the people out there in the industries than if we make it.

Mr. **Wolpe**. Under the new tax incentives for research and development, can you depreciate laboratory equipment that is capital equipment?

Mr. **Tribble**. I don't believe that the IRS has made the determination on that. Have they?

Mr. **Wolpe**. I think you will find that the answer is no to that.

Mr. **Tribble**. Yes.

Mr. **Wolpe**. Under the new tax incentives for research and development, can you include utilities consumed for experiments, gas and electric?

Mr. **Tribble**. No, but the provisions now are such that you can buy stock in the utility and you can, if you reinvest the dividends, defer the taxes on it.

Mr. **Wolpe**. Under the new tax incentives for research and development, can you include employee benefits?

Mr. **Tribble**. I am not that familiar with the——

Mr. **Wolpe**. I think the answer again is no. You cannot include the overhead normally applied to scientists and engineers, nor can you include the normal maintenance work done to support the research and development laboratory.

Now, let me just say that I was struck by the distinction between the tax credit on the one hand and tax cut on the other.

Mr. **Tribble**. Yes.

Mr. **Wolpe**. I think that it is rather—and I happen to support much of the tax credits that were introduced for research and development.

Mr. **Tribble**. Sure.

Mr. **Wolpe**. However, the proposition that somehow there is a distinction, the only distinction is that a tax credit is a tax cut that goes for only a specific few individuals or interests, if there is a distinction at all, rather than an across-the-board reduction in tax burden.

Mr. **Tribble**. There is no question that the purpose appears to be served that a tax credit is a Government effort to subsidize a particular activity.

Mr. **Wolpe**. That is right. I just wanted to see if—you keep referring to this proposition that somehow what was being proposed here was that we simply borrow to pay for an expenditure. I am always intrigued by people who are much more comfortable in borrowing to pay for a huge tax cut which is really what we have been doing. Right?

Mr. TRIBBLE. There is no question about it.

Mr. WOLPE. In identifying these projects which you were referring to earlier which you are abandoning, are all other projects that have been dropped—has industry expressed an interest—let me rephrase the question.

What percentage of the projects that are being dropped has industry expressed an interest in picking up?

Mr. TRIBBLE. We have not solicited that information from industry. We have made no concentrated effort to determine if we discontinue this will it be picked up and if so by whom.

Mr. WOLPE. Have you made any concentrated effort to assess the economic impact of the cuts that are being therefore proposed?

Mr. TRIBBLE. We had no studies made.

Mr. WOLPE. Well, I want to thank you, Mr. Tribble, for taking the time to be with the committee. I know that you had some other engagements, and you were patient enough to await the conclusion of the panel so we could ask a few additional questions. I thank you for that.

Again, I want to thank the panel that appeared before this committee today.

The subcommittee will next meet on Tuesday, March 30, at 1:30 p.m., in room 2318, to hear from the Department on Uranium Enrichment Research and Development and Advanced Isotope Separation Technology.

Thank you very much.

[Whereupon, at 11:17 a.m., the subcommittee was recessed.

APPENDIX

Questions and Answers Submitted for the Record

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
SUITE 2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, D.C. 20515
(202) 225-6371

March 18, 1982

Dr. Shelby T. Brewer
Asst. Secty. for Nuclear Energy
U. S. Department of Energy
Washington, D. C. 20585

Dear Shelby:

We appreciated having Messrs. Dillon, Coffman and Chipman testify before the Subcommittee on the Department's Nuclear Fission programs. Chairman Bouquard would like to supplement the record of the hearing with some additional questions that the Subcommittee has regarding the programs.

We appreciate your cooperation on this matter. If you have any general questions regarding this request, please contact me at 225-8056. If you have any questions regarding a specific program, please contact the appropriate staff member (a copy of staff assignments is attached).

Sincerely,

Jack

JOHN V. DUGAN, JR., Staff Director
Subcommittee on Energy Research
and Production

JVD:jms
Enclosures

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

MAJORITY STAFF PROGRAMMATIC ASSIGNMENTS

NUCLEAR	
Fission: Conventional Reactor Systems	
Light Water Reactor Safety Uranium Utilization/Occupational Dose Reduction	Lou Ventre (support: Ray Pennotti)
HTGR & LWR Reprocessing	Ron Williams (support: Nelson Milder)
Three Mile Island	Lou Ventre (support: Ray Pennotti)
Civilian Nuclear Waste Management and Spent Nuclear Fuel	Lou Ventre
Advanced Nuclear Systems (Space & Terr.)	Harlan Watson (support: Nelson Milder)
Breeder Reactor Systems	Nelson Milder (support: Ron Williams)
Uranium Enrichment	Harlan Watson
Magnetic Fusion	Harlan Watson
NRC Safety Oversight	Lou Ventre and Ray Pennotti
NON-NUCLEAR	
Electric Energy Systems	Ron Williams
Energy Storage Systems	" "
Small-Scale Hydroelectric	Ray Pennotti

NUCLEAR FISSION PROGRAMS - ADDITIONAL QUESTIONS
MARCH 16, 1982

Advanced Nuclear Systems

- In his testimony before the Subcommittee, Mr. Chipman stated that a minimum of $5.3 million would be required for FY 1983 to maintain the flight RTG program. What would these funds be used for?
- Describe the current interest of NASA and the Department of Defense in the Space Reactor Development Program.
- What role has the DOE had in the development of Radioisotope Thermoelectric Generators and nuclear reactor power systems?
- How has DOE managed other joint nuclear programs in the past?
- Is there any reason that the Space Reactor Development Program should not be managed in a similar way for past joint nuclear programs?
- Mr. Fiske's letter to me, dated March 11, 1982, shows an additional FY 1982 reduction of $349,000 for space and terrestrial systems. Where will this reduction be applied and what will be the impact on the FY 1983 program?
- Your budget eliminates funding of advanced R&D for isotope power sources which will impact future development of thermoelectric materials suitable for very high power applications. Have you discussed the impact of this decision with NASA or DOD as far as their future requirements are concerned?
- The budget request transfers about $2.5 million from the RTG development activity to the SP-100 project. What is the impact of this decision on the Galileo flight schedule? Has NASA concurred on this arrangement in priorities?
- Please enumerate how many RTGs have been fabricated by DOE under the R&D budget and identify the customers for these units.
- Please explain what R&D is required before a space reactor can be flight tested.
- The Congressional Budget Request for the Space and Terrestrial Applications program notes that the FY 1983 "activities will be directed toward the develop-

ment of the isotope power sources for the NASA Galileo spacecraft planned for launch in 1985 and the NASA/European Space Agency (ESA) International Solar Polar Mission (ISPM) spacecraft planned for launch in 1986. Hardware delivery schedules for the Galileo and ISPM power sources may be delayed. The effect of these potential delays on the Agency's commitments to meet NASA mission requirements is currently under review."

(a) Identify these "potential delays."

(b) What additional resources are required to meet the present hardware delivery schedules for the Galileo and ISPM power sources?

- What is the justification of providing funding for the work performed under the Terrestrial Applications subprogram (i.e., the City of Albuquerque full-size sludge irradiator) from the Defense Waste Management program?

Waste Program - General

- How did you calculate the expected revenues from the annual fees to utilities?
- What sites are the furthest along in the site characterization process for a repository, and when will the three sites be characterized?
- What is the basis for continuing the Climax Spent Fuel Testing program, and how much money is in the FY 83 budget for this activity?

West Valley

- What funding is needed just to maintain the site at status quo?

Remedial Action

- Was any fee charged in the Shippingport power rates to recover the cost of decontamination and decommissioning?

Nuclear Fuel Cycle

- What utilities are involved in the dry storage demo program and in the other spent fuel R&D programs and what do the utilities contribute to these projects?
- Do you believe that either the utilities or industry will buy Barnwell? If not, what do you foresee happening to that plant? How will reprocessing be accomplished?

In the Committee report to accompany H.R. 6627, the following language indicated the intent of the Members: "The Committee provided $2.5 million under Plant and Capital Equipment in Title VII for negotiations with the owners of the Barnwell Nuclear Fuel Plant at Barnwell, South Carolina." The language went on to state that the negotiations were for the purpose of leasing or purchasing the plant. Did DOE enter into negotiations with the owners of Barnwell for lease or purchase? If so, how extensive were the negotiations and what is the current status?

- What consideration has DOE given to off-budget financing of either Barnwell or a new reprocessing plant?
- With the unfortunate history of West Valley and certain concerns about other commercially owned facilities in the nuclear fuel cycle, how would DOE suggest that worker exposure to radiation be minimized in the future considering profit and loss motivation vs. fallibility of procedures and need for larger investments and higher operating costs?

LWR Safety Technology

- The FY 83 budget request states that DOE will "concentrate efforts on ameliorating regulatory impacts." How do you reconcile this with the specific research areas that the Department was directed to cover by P.L. 96-567?
- Your testimony cites the submission of a Comprehensive Program Management Plan on LWR Safety as an accomplishment for FY 82 despite the fact that the Committee on Science and Technology found this plan unacceptable. What response are you preparing to Mr. Fuqua's February 23 letter to Secretary Edwards asking for a substantive plan by April 15?
- You spoke in your testimony of identifying overlaps and holes in the national nuclear safety R&D budget. Through what mechanism, within the constraints of your $1 million budget request, do you plan to impact NRC's $200 million R&D budget?

LWR Dose Reduction

- How much does occupational radiation exposure contribute to the overall risk of nuclear powerplants; and if the contribution is significant, why was the program eliminated?
- Please describe the trend in occupational radiation exposure in nuclear powerplants. How does this compare with analogous statistics in the nuclear Navy?

LWR Extended Burnup

- Is the technology being developed for extended burnup in PWRs readily transferrable to BWRs; and if not, why does the Department plan to have only one demonstration?
- If the program is confined to one fuel vendor, is that vendor likely to gain a competitive advantage over other domestic fuel suppliers; and if so, why should the government fund the program?

Three Mile Island Activities

- What are the Department's major research objectives with respect to the reactor core at TMI-2?
- What is the current schedule to achieve these objectives and how does it relate to GPU's initiatives in exposing and removing the reactor core?

High Temperature Gas Reactor

- Congress has appropriated $100 million over the last 3 years for the HTGR. This represents a sizeable commitment of public funds which is entrusted to the DOE. The DOE distributes these funds to General Atomic, Gas Cooled Reactor Associates, General Electric and ORNL. This clearly places DOE in an HTGR Management role. The question is, how is the HTGR program to be managed? Specifically, who has or will have prime responsibility? How does DOE plan to manage lead projects?

- How will the 29 supporting utilities interface with the program activities? In other words, will there be a single voice, that of the Gas Cooled Reactor Associates, or will individual utilities have approval/disapproval rights?
- How will the users of the lead project participate in this program? What authority will they have? How will they participate in the management of the project?
- What is DOE's opinion of the technical parameters of the lead project? Specifically, are the reactor performance limits sufficiently high to advance the state of the art without incurring excessive risk?
- What is your opinion of the lead plant time schedule which exceeds 11 years? How can the time to design and build a plant be significantly reduced?
- Other than the lead plant, what program elements do you feel warrant government support?

ADVANCED NUCLEAR SYSTEMS

Q. In his testimony before the Subcommittee, Mr. Chipman stated that a minimum of $5.3 million would be required for FY 1983 to maintain the flight RTG program. What would these funds be used for?

A. $2.5 million dollars would support fuel form production, encapsulation, heat source assembly, fueled generator test, and converter production operations. $2.8 million dollars would be used to provide quality assurance, technical support, and increasing the nuclear safety activities commensurate with the safety requirements.

Q. Describe the current interest of NASA and the Department of Defense in the Space Reactor Development Program.

A. In recognition of the technological capability that a space nuclear power system could bear upon NASA planetary missions in the 1990's, NASA elected to support the DOE's development program in FY 1982 and beyond. In parallel with the NASA support, we became aware of the DOD's Defense Science Board assessments that were being conducted in the summer of 1981 and that ultimately recommended support of a space nuclear reactor development program. Subsequently, the Defense Advanced Research Projects Agency (DARPA) completed its assessment of space nuclear power and advised us in February 1982 that they would support an advanced space reactor technology program provided that satisfactory management arrangements could be agreed upon. Currently, discussions are underway with both NASA and DARPA on this matter.

Q. What role has the DOE had in the development of Radioisotope Thermoelectric Generators and nuclear reactor power systems?

A. Since the beginning of the space nuclear power program, the DOE and/or its predecessors have provided both the radioisotope heat source and the thermoelectric generators as a proven and qualified flight power system for NASA and DOD space missions. The basic thermoelectric conversion technology for the radioisotope thermoelectric generator has been successfully carried out by this agency for space nuclear power missions dating back to 1961.

In the space nuclear reactor power area, the predecessor (AEC) of the Department of Energy had the total responsibility for the development of the reactor and power conversion system, the SNAP-10A, which was successfully launched into space by the Department of Defense in 1965.

Q. How has DOE managed other joint nuclear programs in the past?

A. In all cases where other agencies have been involved with the DOE (AEC, ERDA) in nuclear programs, a joint program office was established and DOE was designated the lead agency. In the case of the space nuclear rocket propulsion program, a joint AEC/NASA office was organized within the AEC to manage and direct that work. Similar joint office organizations, which have been successful in providing coordinated management and direction, include the Army Nuclear Power Program, the Maritime Nuclear Propulsion Program, and the Naval Reactors Program.

Q. Is there any reason that the Space Reactor Development Program should not be managed in a similar way for past joint nuclear programs?

A. No.

Q. Mr. Fiske's letter to me, dated March 11, 1982, shows an additional FY 1982 reduction of $349,000 for space and terrestrial systems. Where will this reduction be applied and what will be the impact on the FY 1983 program?

A. This reduction has been applied to the Byproduct Utilization Program. It will result in a reduced effort on the sludge irradiation program, which is supporting the City of Albuquerque for development of a full-size irradiator. Responsibility for the sludge irradiation program has been transferred to the Defense Nuclear Waste Program in FY 1983.

Q. Your budget eliminates funding of advanced R&D for isotope power sources which will impact future development of thermoelectric materials suitable for very high power applications. Have you discussed the impact of this decision with NASA or DOD as far as their future requirements are concerned?

A. The Agency is in the process of entering into discussion with NASA on the funding constraints which are associated with the Advanced Thermoelectric Activities in support of future NASA and DOD space missions.

Q. The budget request transfers about $2.5 million from the RTG development activity to the SP-100 project. What is the impact of this decision on the Galileo flight schedule? Has NASA concurred on this arrangement in priorities?

A. The reduction of fuel form production and encapsulation operations at Savannah River Plant is under consideration, in addition to the reduction of assembly and testing operations of flight fueled units at the Mound Facility and Converter fabrication work at General Electric.

The result of these reductions on the flight RTG program may result in the Agency's inability to meet NASA's flight hardware schedule for the Galileo mission.

The Agency is continuing discussion with NASA on these potential delays.

Q. Please enumerate how many RTGs have been fabricated by DOE under the R&D budget and identify the customers for these units.

A. Thirty-eight flight units and 16 engineering and qualification units have been fabricated by DOE (or its predecessor agencies) for use by NASA and DOD.

Q. Please explain what R&D is required before a space reactor can be flight tested.

A. The planned R&D required in preparation for a flight test of a Space Nuclear Reactor Power System (SP-100) is divided into three phases: Critical Technology Development, Ground Engineering System, and Flight Application. During the Critical Technology Development Phase, emphasis will be placed on development of materials and component technologies and identifying specific and generic requirements for the SP-100. At the completion of this phase, a program review is planned to be held and a key decision will be made prior to proceeding into the Ground Engineering System Phase. Should the program proceed into the second phase a ground demonstration system will be fabricated and tested simulating space operating conditions as much as possible. During the Flight Qualification Phase, a SP-100 power system would be developed that would be suitable for flight testing. The Critical Technology Development Phase is planned to be completed by FY 1986. A flight qualified system could be ready for flight testing by the end of FY 1992.

Q. The Congressional Budget Request for the Space and Terrestrial Applications program notes that the FY 1983 "activities will be directed toward the development of the isotope power sources for the NASA Galileo spacecraft planned for launch in 1985 and the NASA/European Space Agency (ESA) International Solar Polar Mission (ISPM) spacecraft planned for launch in 1986. Hardware delivery schedules for the Galileo and ISPM power sources may be delayed. The effect of these potential delays on the Agency's commitments to meet NASA mission requirements is currently under review."

(a) Identify these "potential delays."

(b) What additional resources are required to meet the present hardware delivery schedules for the Galileo and ISPM power sources?

A. (a) The reduction of fuel form production and encapsulation operations at Savannah River Plant is under consideration, in addition to the reduction of assembly and testing operations of flight fueled units at the Mound Facility and converter fabrication work at General Electric. This slippage occurs because the number of personnel who may be terminated in FY 1983 could not be rehired and retrained in FY 1984.

(b) A minimum of $5.3M would be required for FY 1983 to maintain the flight RTG program.

Q. What is the justification of providing funding for the work performed under the Terrestrial Applications subprogram (i.e., the City of Albuquerque full-size sludge irradiator) from the Defense Waste Management program?

A. The Byproduct Utilization Program is tasked with demonstrating the beneficial uses of the defense byproduct, Cesium-137. This program has been transferred to Defense Waste Management in order to better align the program management and funding responsibility with the responsibility for the byproduct.

Waste Program - General

Question

How did you calculate the expected revenues from the annual fees to utilities?

Answer

The Office of Nuclear Energy's projected revenues from the annual utility fee are based on the following nuclear growth projection:

Year	GWE
1983	83
1984	95
1985	104
1986	119
1987	125

The calculation assumed a 60% capacity factor or, in other words, about 5,260,000,000 kilowatt-hours per Gwe-year. The 60% capacity factor reflects recent experience for nuclear power plants.

In addition, to recognize the lead time required to put this financing approach in place, the 1983 revenues are projected for 8 months instead of a full year.

Waste Program - General

Question

What sites are the furthest along in the site characterization process for a repository, and when will the three sites be characterized?

Answer

The Department's current schedule calls for detailed site characterization of three candidate sites to begin in CY 1983. This phase of study will include in-situ experiments at the bottom of an exploratory shaft, and is planned for completion by September 1987. The basalt location at the Department's Hanford Site is furtherest along with exploratory shaft development planned to begin in early CY 1983. A specific location of welded tuff at Yucca Mountain on the Nevada Test Site has been identified for exploratory shaft development by mid-1983. Salt domes in Louisiana and Mississippi and salt beds in Texas and Utah are at roughly comparable levels of study, and a decision to begin development of an exploratory shaft at one of these potential salt locations is planned by December 1983. Detailed site studies of the three exploratory shaft sites should be completed by September 1987 with a preferred candidate recommended by early FY 1988.

Crystalline (granitic) rock formations in three Lake Superior States and fourteen states along the Appalachian Mountain Chain have been identified as potentially attractive but are only in the initial phases of the site exploration program. No field investigations have been undertaken or are planned during these early regional studies. The Department expects to make recommendations concerning areas worthy of further investigation among these potential candidates late this calendar year and to later qualify a site in granite as an alternative for follow-on repositories according to a planned system of regional repositories.

Waste Program - General

Question

What is the basis for continuing the Climax Spent Fuel Testing program, and how much money is in the FY 1983 budget for this activity?

Answer

The spent fuel storage test in the Climax facility at the Nevada Test Site was initiated in May 1980 to evaluate the effects of storage of spent fuel and high-level waste in granite. Eleven canistered spent fuel assemblies from commercial reactors were emplaced in boreholes in a newly mined section of an existing facility 1400 feet below the surface. The facility, originally used to support underground weapons tests, was newly instrumented to observe the conditions and characteristics (1) before emplacement, (2) after emplacement, and (3) after the removal of the spent fuel when the facility is naturally cooled to near the original ambient temperature. The effects of temperature and radiation of stress and displacement of the rock and the effects of the spent fuel package are being observed. The temperatures are now stabilized and the radiation to the surrounding rock has approached a significant level. Temperatures, stresses, and displacements have been observed throughout the operation to date.

The basis for continuing the spent fuel test is the accumulation of technical information which fulfills the test objectives discussed above. The accumulated data and operating history are being reviewed in FY 1982 as a basis for a decision on how long the test should be continued. The budget for FY 1983 for this facility is approximately $3.0 million. This budget will be required to continue the testing program or to proceed with test shutdown and fuel retrieval from Climax.

West Valley

Question

What funding is needed just to maintain the site at status quo?

Answer

Approximately $8M (estimated FY 1983 dollars) is required annually to maintain the site status quo, which includes labor and material for routine maintenance and operations, site security, utilities and custodial care. This funding level also includes funds to upgrade the facility to meet DOE health, safety, and security standards and requirements.

Remedial Action

Question

Was any fee charged in the Shippingport power rates to recover the cost of decontamination and decommissioning?

Answer

No. The Department of Energy owns all the radioactively-contaminated portions of the Shippingport plant and has responsibility for the decontamination and decommissioning of these portions of the plant and the site. Appropriations for this purpose will be requested from Congress in future years.

Nuclear Fuel Cycle

Question

What utilities are involved in the dry storage demo program and in the other spent fuel R&D programs and what do the utilities contribute to these projects?

Answer

Only the Tennessee Valley Authority (TVA) is currently participating in a cooperative demonstration of dry storage technology. A licensed demonstration of dry cask storage is planned for TVA's Browns Ferry Site and is scheduled to begin in June 1983. TVA is also participating in a cooperative demonstration of BWR rod consolidation. This is a licensed demonstration and is scheduled for January 1983 at Browns Ferry. The Department is also pursuing another cooperative program that will demonstrate the consolidation of PWR spent fuel assemblies on a licensed basis at a reactor, followed by the licensed shipment of consolidated rods in shipping casks and the unlicensed demonstration of a large capacity dry storage cask at a Government site.

As part of these cooperative programs, the utilities are expected to provide the reactor site and spent fuel used in the licensed storage operations. In addition, the utilities and private industry would provide the site specific equipment, personnel, and licensing documentation required and also any transportation services that are required. The Department will support licensing by developing generic licensing information that can be used by all utilities and by conducting unlicensed storage operations at a Government site with utility supplied fuel and casks.

Nuclear Fuel Cycle

Question

Do you believe that either the utilities or industry will buy Barnwell? If not, what do you foresee happening to that plant? How will reprocessing be accomplished?

Answer

We are optimistic that the private sector can and will provide a domestic reprocessing capability, provided certain Government actions are taken to create a more stable, less risky environment. For example, actions are necessary to financially protect a reprocessor against possible future policy changes. We expect to provide recommendations for specific actions in these and other areas within the next several months.

Nuclear Fuel Cycle

Question

In the Committee report to accompany H.R. 6627, the following language indicated the intent of the Members: "The Committee provided $2.5 million under Plant and Capital Equipment in Title VII for negotiations with the owners of the Barnwell Nuclear Fuel Plant at Barnwell, South Carolina." The language went on to state that the negotiations were for the purpose of leasing or purchasing the plant. Did DOE enter into negotiations with the owners of Barnwell for lease or purchase? If so, how extensive were the negotiations and what is the current status?

Answer

The Department never received the $2.5 million for negotiations because legislation to provide it was never enacted. The Department did not enter into negotiations with the owners of Barnwell for leasing or purchasing the facility.

In late 1980, in response to a direction by Congress, the Department did enter into discussions with the owners of Barnwell and the Morris facility to determine terms and availability of potential storage sites. This activity was requested in House of Representatives Report 96-1093 which accompanied H.R. 7590, "Energy and Water Development Appropriation Bill 1981," (Pub. L. 96-367). It is important to note that this Congressional direction and the subsequent discussions were associated with spent fuel storage, not reprocessing. The results of these discussion were provided to Congress by the Department in a "Report on Discussions with Owners of Potential Spent Fuel Storage Facilities," DOE/SR-0008, January 1981.

Nuclear Fuel Cycle

Question

What consideration has DOE given to off-budget financing of either Barnwell or of a new reprocessing plant?

Answer

The President has indicated his view that the private sector should take the lead in providing a domestic reprocessing capability. DOE supports this view, hence has given no consideration to off-budget financing of either Barnwell or a new reprocessing plant.

Nuclear Fuel Cycle

Question

With the unfortunate history of West Valley and certain concerns about other commercially owned facilities in the nuclear fuel cycle, how would DOE suggest that worker exposure to radiation be minimized in the future considering profit and loss motivation vs. fallibility of procedures and need for larger investments and higher operating costs?

Answer

The Nuclear Fuel Services' (NFS) Reprocessing Plant at West Valley, New York was the first attempt at the commercialization of fuel reprocessing based on technology and engineering approaches available in the early 1960's. Valuable information was obtained during its operation from April 1966 to November 1971 including occupational exposure data.

Radiation exposure goals for workers in nuclear facilities are tending toward those for the general public. Efforts in the Department's Fuel Reprocessing Research and Development program are directed toward meeting or exceeding those goals based on facility design concepts utilizing total remote operation and maintenance. These concepts are based on continuing developments and advances in electromechanical manipulator design, process instrumentation, modular equipment design and in-cell automatic sampling. The application of these techniques will remove the principal sources of plant personnel exposure that were experienced at the NFS plant. The use of these concepts may add to the cost of a reprocessing plant but they also provide economic benefits including a reasonable degree of assurance that high operating factors would be achieved, as well as enhanced safeguards, safety and environmental protection. On balance, the cost per unit processed would probably be acceptable.

The Department suggests that a system approach to reduce occupational exposure be used in future plants, much as described above, in which a number of objectives will be met, including low radiation exposure limits, by appropriate engineering design of a totally integrated facility.

LWR SAFETY TECHNOLOGY

Q. The FY 1983 budget request states that DOE will "concentrate efforts on ameliorating regulatory impacts." How do you reconcile this with the specific research areas that the Department was directed to cover by P.L. 96-567?

A. An objective of the LWR Safety program is to provide the technical bases to support institutional and regulatory modifications. In FY 1983, the Department will examine nuclear regulations, such as 10 CFR 50 Appendix K, to determine if sufficient technical bases have been developed since the regulations were written to warrant relaxation of assumptions and thereby the regulations themselves. Evaluations will also determine what additional effort would be required to warrant relaxation in other regulations if the present technical bases are insufficient. Any additional work that may be required is expected to be covered by P.L. 96-567.

Q. Your testimony cites the submission of a Comprehensive Program Management Plan on LWR Safety as an accomplishment for FY 1982 despite the fact that the Committee on Science and Technology found this plan unacceptable. What response are you preparing to Mr. Fuqua's February 23 letter to Secretary Edwards asking for a substantive plan by April 15?

A. The Department's response to Mr. Fuqua's letter of February 23 to Secretary Edwards will contain the information requested in items (1) through (4) in the letter. The use of working groups to help establish program direction is, as Mr. Fuqua pointed out, time consuming and one that I feel is absolutely necessary. As the Department indicated in the schedules of efforts for the working groups, none of the reports will be in final form on April 15, 1982. We will label all of the reports as preliminary and will provide a schedule for completing and submitting final reports and plans. As described in Secretary Edwards' letter to Mr. Fuqua in response to another section of Mr. Fuqua's letter of February 23, the working groups have made sufficient progress to identify high priority efforts that should be performed. Our response on April 15 will provide plans and schedules for completing these high priority efforts.

Q. You spoke in your testimony of identifying overlaps and holes in the national nuclear safety R&D budget. Through what mechanism, within the constraints of your $1 million budget request, do you plan to impact NRC's $200 million R&D budget?

A. When the Definition Phase working groups in the Department's program have identified the R&D efforts that should be undertaken to complete resolution of safety issues, the Department will meet with NRC, Electric Power Research Institute, Institute of Nuclear Power Operations, and the nuclear industry to develop plans and schedules for completing the efforts identified by the working groups. The Department will revise the existing memorandum of understanding or enter a new memorandum of understanding for the management and completion of these efforts. The Department will also coordinate with foreign nuclear safety programs to minimize unnecessary duplication of efforts and to minimize costs.

LWR RADIATION DOSE REDUCTION

Q. How much does occupational radiation exposure contribute to the overall risk of nuclear powerplants? If the contribution is significant, why was the program eliminated?

A. The primary risks from nuclear powerplants come from potential accidents and occupational exposure. There is a difficulty, however, in comparing the risk from occupational exposure to that from potential accidents since one has to deal with the two extremes of the risk curve. The actual average exposure to occupational workers in 1980 is a known, measurable quantity (791 man-rem/plant or 0.67 rem/person). For potential accidents, however, probability events and consequences are assumed. The expected value for the radiation exposure for the whole range of accident probabilities and consequences can be calculated. On this basis, the occupational exposure (0.67 rem/person), which is well within the Federal safety criterion of 5 rem/person/year, is a significant contribution to the overall risk of a nuclear powerplant (which is itself low).

Since the average occupational exposure is well within the safety criteria, the incentive to reduce occupational doses even lower comes primarily from the ALARA criterion. ALARA means to reduce doses to As Low As Reasonably Achievable. The Department, while supporting the ALARA concept, believes the major improvements in reducing occupational exposures will be ones that also improve plant availability or directly benefit the utility in some other way. Thus, funding for dose reduction improvements should be primarily with the industry itself.

Q. Please describe the trend in occupational radiation exposure in nuclear powerplants. How does this compare with analogous statistics in the in the nuclear Navy?

A. Occupational radiation exposure in nuclear powerplants has increased steadily since the inception of commercial nuclear power. From 1970 to 1980, the yearly total light water reactor exposure has grown from 4,000 to 54,000 man-rems. The primary reasons for this increase in exposures are: (a) increasing levels of plant contamination with age; (b) more severe regulatory requirements for inservice inspections and retrofits; and, (c) the increasing number of installations. Even though the exposure per plant has increased, the average exposure to individual workers has remained relatively constant (approximately 0.67 man-rem per worker per year) since 1970, through the use of increased manpower levels.

The nuclear Navy occupational radiation exposure exhibited a similar trend prior to 1966. The nuclear Navy was able to reverse the trend by improved technology and operational and maintenance practices. The specific information on the technological developments, as well as operational and maintenance improvements, are not available to the light water reactor industry. However, the fact remains that occupational radiation exposures can be significantly reduced.

LWR EXTENDED BURNUP

Q. Is the technology being developed for extended burnup in PWRs readily transferable to BWRs; and if not, why does the Department plan to have only one demonstration?

A. Much of the basic design and licensing data being developed is applicable to both types of light water reactors. Demonstration of the performance of any one specific design is generally not fully transferrable to other designs. Our primary reason to plan for only one demonstration is to reduce Government expenditures in a time of severe budget restraints.

Q. If the program is confined to one fuel vendor, is that vendor likely to gain a competitive advantage over other domestic fuel suppliers; and if so, why should the Government fund the program?

A. Confining the demonstration to a single fuel design unavoidably confers some competitive advantage to the firm whose design is chosen. We would minimize that advantage by requiring full and prompt publication of results from the one demonstration going forward, as well as through support of the basic design and licensing data activities which should be of equal value to the entire industry. This approach represents a minimum cost way for the Nation to attain the benefits of this program without undue delay. Without Government support these benefits would not be obtained.

THREE MILE ISLAND ACTIVITIES

Q. What are the Department's major research objectives with respect to the reactor core at TMI?

A. The major objectives are to examine the TMI-2 reactor core and core components, to evaluate licensing criteria, and to analyze failure mode causes and effects. These analyses will be used to determine the extent of damage to the reactor core; this information will be used to determine the most feasible ways of defueling the reactor and will provide information to improve safety criteria and requirements, improve design reliability and enhance operation and maintenance capabilities.

Q. What is the current schedule to achieve these objectives and how does it relate to GPU's initiatives in exposing and removing the reactor core?

A. The Department currently plans to support the reactor core removal and its examination in 1984. Objectives associated with inspection and data acquisition activities, which are part of the defueling program, will provide the bulk of the in situ data needed for the generic safety R&D. Analysis of core damage will take place at Idaho National Engineering Laboratory and other appropriate laboratories after shipment from TMI. The actual date of core removal will depend upon the amount of funds which General Public Utilities (GPU) will be able to apply to its recovery efforts, as well as the determined condition of the reactor core. The Department's program will not interfere with GPU's efforts.

HIGH TEMPERATURE GAS REACTOR

Q. Congress has appropriated $100 million over the last 3 years for the HTGR. This represents a sizable commitment of public funds which is entrusted to the DOE. The DOE distributes these funds to General Atomic, Gas-Cooled Reactor Associates, General Electric and ORNL. This clearly places DOE in an HTGR management role. The question is, how is the HTGR program to be managed? Specifically, who has or will have prime responsibility? How does DOE plan to manage lead projects?

A. The HTGR program is now managed by DOE. The Assistant Secretary for Nuclear Energy is responsible for the HTGR program. The program is assigned to the Director of the Office of Nuclear Power Systems who delegates management responsibility to the Director of the High Temperature Reactor Program. The latter has prime responsibility for overall program direction, approval, and successful implementation within overall costs and schedule. Through DOE directives, he gives direction to the appropriate DOE Field Offices. The appropriate Field Offices direct the National Laboratories and contractors which provide day-to-day management of individual projects. They have the responsibility for performing the program and meeting headquarters-approved milestones. Although no funding was requested for continuing the HTGR program in FY 1983, the Agency intends to encourage private industrial initiatives. The question regarding management of possible future lead projects cannot be explicitly answered until the details of these private initiatives have been worked out.

Q. How will the 29 supporting utilities interface with the program activities? In other words, will there be a single voice, that of the Gas-cooled Reactor Associates, or will individual utilities have approval/disapproval rights?

A. In the past, the supporting utilities' interaction with the HTGR program was through the Gas-Cooled Reactor Associates (GCRA). GCRA was established by the participating utilities to provide a single entity through which they deal with both the Government and private sector. Utility input to GCRA is assured through a management structure consisting of a Board of Directors and Management Committee whose members are elected by the member utilities. Additional utility input to GCRA is provided through a Technical Advisory Committee and a Process Heat Advisory Committee. We assume this arrangement would continue in the future.

Q. How will the users of the lead project participate in this program? What authority will they have? How will they participate in the management of the project?

A. The role of the users of the lead project in the HTGR program cannot be defined unless a utility/user commitment to build a plant is made and a project established. In the absence of a specific user organization, the lead project in the Department's current program is being designed to accommodate a wide spectrum of user requirements.

Q. What is your opinion of the lead plant time schedule which exceeds 11 years? How can the time to design and build a plant be significantly reduced?

A. Based on FY 1982 Congressional authorization, proposed lead project schedules are being developed assuming funding profiles and initiation dates as well as a four-phase program in which the participants decide whether to proceed with the project at the end of each phase. Perhaps as much as 2 years could be saved from the schedule if a firm commitment and commensurate funding profile authorization could be obtained from all parties at the onset of the project. This savings would be accomplished by carrying out parallel design and component procurement efforts which are now planned to be series activities. Additional time could be saved by an earlier selection of a specific site for the project.

Q. Other than the lead plant, what program elements do you feel warrant government support?

A. If a private sector lead plant initiative does not evolve, no other elements of the program warrant government support. If such an initiative did evolve other program elements could be considered.

The ultimate use of the HTGR is thought to be in the industrial market as a supplier of very high temperature process heat. Therefore, elements of a program that further this application may warrant support. They include the development of high temperature structural alloys, improved graphite, and thermal barrier materials. In addition, application studies and conceptual designs would be needed to guide the development programs.

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MINORITY STAFF DIRECTOR

March 30, 1982

Mr. Joseph J. Tribble
Asst. Secty. for Conservation
  and Renewable Energy
U.S. Department of Energy
Washington, DC 20585

Dear Mr. Tribble:

I appreciate your attending our March 25, 1982 hearing on Electric Energy Systems, Energy Storage Systems, and Small-Scale Hydroelectric power research and development programs. I also appreciate your staying for the duration of the hearing and understand it required some adjustment of your schedule in response to our needs.

The attached questions are pursuant to the hearing discussions and I request that you answer them for the record by April 15, 1982.

Regarding differences in philosphy, the Committee is not interested in providing federal subsidies for unfocused research in which there is no private sector interest in developing or demonstrating technology. We are interested, however, in seeing the continuation of research which is in the national interest when private industry is either unable or unwilling to proceed with the necessary effort on their own. The Committee is equally concerned about the inability of industry to plan a national strategy and assure that the combined efforts of all companies and utilities are organized and directed toward fulfilling national needs and/or optimizing international market prospects for new technologies. To me, even based on solely economic arguments, the precipitous withdrawal of federal support is a tragic mistake.

Sincerely,

Marilyn Bouquard

MARILYN L. BOUQUARD, Chairman
Subcommittee on Energy Research
  and Production

MLB:Wma
Attachments

'82 MAR 31 [illegible]

QUESTIONS RELATED TO ELECTRIC ENERGY SYSTEMS, ENERGY STORAGE SYSTEMS, AND SMALL-SCALE HYDROELECTRIC PROJECT

- Your written statement refers to the Administration's commitment to the goals of the economic recovery program and the need to minimize government intervention in the marketplace. Would you explain how the government intervenes in the market by doing research on the aluminum air battery at the Lawrence Livermore Laboratories?
- You stated, "Today the energy situation does not appear as intractable as it appeared when these legislative programs were enacted." (Meaning solar, conservation, etc.) Do you mean the situation is now easier to control or that it is now easy to cure? How do you use the word intractable? Recognizing that the slowing of consumption by higher prices will extend finite resources, what is your projection for the useful life and our coal, oil, gas and uranium resources?
- You mentioned that oil imports into the U.S. are down 50%. How many dollars per year in payments to foreign countries are now anticipated at this lower level? Is this good economics?
- Does not this amount constitute a drain on American earner wages?
- Would it not strengthen the U.S. economy to spend this money internally?
- Would you therefore advocate continuing to raise prices until the imports drop to zero? What impact do you believe this would have on disposable income of the average American?
- Since you mention that "relatively inexpensive energy, one of the basic building blocks of our economy, was becoming a thing of the past," etc., and since you also attribute virtually all of the gains in conservation to higher costs of energy, would you explain the ramifications for economic growth of the constraint of increasingly expensive energy?

- What specific batteries does the Administration's R&D budget for FY 1983 support? How much funding is included? And what specific purposes will this money be used for?
- Your written statement mentions, "DOE now supplies electrochemistry development work specifically directed toward improving the energy efficiency of industrial processes." What does that mean?
- You also mention this work parallels developments concurrently being supported by large sophisticated industries who are capable of increasing in-house R&D. Who are these sophisticated companies and precisely what are they doing that is the same as what DOE is doing?
- In the budget you requested $7.22 million mostly for energy storage. Without generalizing and using terms like thermodynamics, kinetics, or generic research, in detail, exactly what is that request for, what is to be accomplished and by whom?
- Summarize now and submit in detail for the record an account of all prior R&D investments made by DOE in Electric Energy Systems and Energy Storage for each and every project funded in FY 1981 but for which no funds have been requested in FY 1983. For each project, list the work accomplished to date, the amount of R&D yet to be completed in order to benefit the public, the estimated cost of the remaining R&D and the projected future economic impact should the work not be carried forward by industry or the utilities.
- You have obviously assessed the future benefits to the American public of continuing federal involvement in Electric Energy Systems and found there were none. Describe now and present in detail for the record your complete cost/benefit analysis on this program which led to this conclusion.
- How much oil could be saved per year if advanced storage batteries can be developed and electric vehicles were competitive in the market?

- In 1980 the federal government invested $37 million in Electric Energy Systems and EPRI invested about $30 million. Do you have any idea how much industry invested?
- Have you completed a national investigation and analysis which identifies what company is going to work on what projects? That is, how all these individual "self-interest" efforts will form one complete national program? If so, can we have a copy of that analysis?
- Present the details on the privately-funded research being performed at Sandia Laboratory that you mentioned during the hearing - that is, what are they doing, what is to be accomplished, how much are they investing per year, and how do they reimburse the government for use of the facilities?
- How can you justify termination of the REDOX program at this time in light of the $6 million investment to date? Several companies have shown interest in cost sharing. What is the status of development and what research remains to be completed?
- In your area of responsibility, Electric Energy Systems, what private companies are working on R&D to develop advanced equipment for:

  Reactive Power Compensation

  Line Protective Systems

  Power Control and Communication Systems

  High Voltage DC Transmission Interface Equipment (that is AC to DC and back to AC)

  1200 KV Gas Insulated AC Power Transfer Systems

  Underground Gas Insulated Transmission
- What is the status of development in these areas?
- What research needs to be done on the biological effects of electric field currents? Who will do this if the government does not?

- What percentage of the cost of bringing a new product to market would you say is R&D? What percentage would be non-R&D and what might be the elements of these costs?
- Do you think industry will perform basic short-term research or long-term research or both? Why?
- What is a realistic pre-tax interest coverage ratio for utility companies to maintain high bond ratings?
- In your opinion, how can industry justify long-term, high risk R&D to its shareholders?
- The North American Electric Reliability Council (NERC) reported in their 11th Annual Review that utility companies are not in a position to make financial investments. What is your basis then for terminating Electric Energy Systems work? Is it that you believe that technology has reached its zenith? What are the stakes for future U.S. markets overseas? Would you compare our prospects with those of the Japanese given our historical adversary relationship between business and the federal government. Doesn't precipitous withdrawal from these R&D programs merely reduce the chances for an effective government/industry partnership?
- Considering the position of Public Utility Commissions (PCUs), how can utility companies finance long-term research?
- In making decisions about investments, how would you expect industry to weigh increased plant capacity and automation against R&D?
- Regarding tax incentives, since 1954, firms have been given the option of fully deducting R&D expenditures in the year in which they occur. What are the differences in the new tax law which will encourage greater R&D commitments by private industry?

- What are the three or four most promising engineering projects that you have been funding in this program? Will these be developed and field-tested if the government program is abandoned? What assurances, if any, do you have that they will be continued?
- Please describe the impact of minimum streamflow requirements recommended by the U.S. Fish & Wildlife Service on Small-Scale Hydro projects. What research has DOE been funding in this area and why?

Department of Energy
Washington, D.C. 20585

April 30, 1982

Honorable Marilyn Lloyd Bouquard
Chairman
Subcommittee on Energy Research
  and Production
House of Representatives
Washington, D.C. 20515

Dear Chairman Bouquard:

Enclosed are responses submitted by the Subcommittee on Energy Research and Production following the March 25, 1982, hearing. Department of Energy witnesses were Maxine Savitz and Joseph Tribble. The subject of the hearing was Electric Energy Systems, Energy Storage, and Small-Scale Hydroelectric Project.

Copies of these responses have been sent to the Subcommittee for the official record.

If you have any questions, please call Ingrid Nelson or Tom Pretorius of my staff on 252-4277. They will be happy to assist you.

Sincerely,

Thomas H. Pretorius
for Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosures

1. Q. Your written statement refers to the Administration's commitment to the goals of the economic recovery program and the need to minimize Government intervention in the marketplace. Would you explain how the Government intervenes in the market by doing research on the aluminum air battery at the Lawrence Livermore Laboratories?

A. A major effort on research and development in this area should be of prime interest to the aluminum companies and/or the battery companies. In an effort to prove the technical feasibility and reduce the risk, the Department of Energy has been funding research at the Lawrence Livermore Laboratories on the aluminum-air battery, and continued work is proposed as part of the FY 1983 budget request, at a funding level of $200,000. This is considered an adequate level of funding to ensure accomplishment of program objectives in an orderly manner.

2. Q. You stated, "Today the energy situation does not appear as intractable as it appeared when these legislative programs were enacted." (Meaning solar, conservation, etc.) Do you mean the situation is now easier to control or that it is now easy to cure? How do you use the word intractable? Recognizing that the slowing of consumption by higher prices will extend finite resources, what is your projection for the useful life of our coal, oil, gas and uranium resources?

A. What is meant by this statement is that energy situation has improved, largely due to market forces, to a point where Federal Government intervention is no longer needed. The term "intractable" would be defined here as "un-changeable."

While it is difficult to predict the individual market choices of energy end users, it is reasonable to expect that conservation and use of renewable energy options will extend the useful life of our coal, oil, gas and uranium resources. However, realistic energy pricing policies make it unlikely that any of these resources would be fully depleted before other energy options displace them. Therefore, although such projections are of limited value, the Energy Information Administration has estimated the number of years that domestic resources can sustain production at the 1980 rate of output. For crude oil and natural gas, including undiscovered recoverable resources, EIA estimates approximately three decades each of production remaining at the 1980 rate of output. For coal, production from demonstrated reserves could be sustained at 1980 rates for an estimated 572 years with additional resources extending production to over 2000 years. The proven reserve lifetime of uranium at 1980 levels of consumption is estimated to be at least 75 years with a potential reserve lifetime of at least of 350 years.

3. Q. You mentioned that oil imports into the U.S. are down 50%. How many dollars per year in payments to foreign countries are not anticipated at this lower level? Is this good economics?

A. According to the latest Monthly Energy Review, March 1982, total energy imports in 1981 had a total merchandise trade value of $81.4 billion. Petroleum imports have historically constituted over 90% of total energy imports. Since we exported slightly over $10.3 billion in energy, our net trade deficit in energy was $71.1 billion. In terms of volume, this was 35% below the peak level of 8.8 million barrels per day in 1977. Current petroleum import levels are even lower, less than one-half the peak level. At the current level of imports, and considering recent prices, these figures would be considerably lower -- probably in the area of $50 billion of total annual energy imports and a net average trade deficit of around $40 billion. Continued reduction in oil imports would contribute to the relative strength of the dollar and improve U.S. GNP in real terms. (Continued reductions in imports will not increase the price of American exports that contain embodied oil. A further reduction in imports resulting from the imposition of a tariff would increase the price of energy exports. It is not clear, however, that a tariff is the subject of the question.)

4. Q. Does not this amount constitute a drain on American earner wages?

A. Imports of oil do not constitute a drain on the earnings of the American worker. If we decrease oil imports by using domestic energy which is more expensive, we increase the cost of oil that is consumed as gasoline and heating oil, as well as the cost of products that are made with oil. These price increases decrease the puchasing power of the wages of the American worker. The worker is better off if we permit the market to decide whether imported oil or domestic oil is a preferable energy source.

5. Q. Would it not strengthen the U.S. economy to spend this money internally?

A. The strength of the U.S. economy depends on how wisely we invest our money. If we force consumers of imported oil to spend their money on more expensive domestic oil, we are making consumers spend more to get less. This is not an intelligent use of American resources, and it would not strengthen our economy.

6. Q. Would you therefore advocate continuing to raise prices until the imports drop to zero? What impact do you believe this would have on disposable income of the average American?

A. Raising prices to encourage a reduction in oil imports would constitute an artificial increase in the price of imported oil above the market price. Such increases, however generated, could direct funds from the private sector that would otherwise be put to productive uses.

7. Q. Since you mention that "relatively inexpensive energy, one of the basic building blocks of our economy, was becoming a thing of the past," etc., and since you also attribute virtually all of the gains in conservation to higher costs of energy, would you explain the ramifications for economic growth of the constraint of increasingly expensive energy?

A. As energy becomes more expensive additional resources will be diverted to energy production, conservation, and the development of alternative sources. The overall growths in economic activity will, of course, be somewhat slower than if energy costs did not rise. The most efficient course we can follow, with the least harmful long-run impact, is to insure that consumers and producers face the true cost of energy when making decisions about the allocation of resources to competing activities.

8. Q. What specific batteries does the Administration's R&D budget for FY 1983 support? How much funding is included? And what specific purposes will this money be used for?

A. The Administration's R&D budget provides $4.9 million to support continuing development of 5 battery types. The overall objective is to provide batteries with low-cost improved performance and long life for application in advanced electric vehicles (EV) as well as in electric utility, solar, and wind energy systems. Specific purposes for which this money will be used include:

Lead-Acid and Nickel/Iron ($2.7 million) - Funding for lead-acid will result in the incorporation of plastic/lead composite grids and improvement of electrode packaging density to vield a specific energy of 45 wh/kg. R&D on nickel/iron batteries will result in the demonstration of full-size vehicle batteries having specific energy of 50 wh/kg and a life in excess of 600 cycles.

Sodium/Sulfur ($1.5 million) - Efforts will continue on improving cycle life by emphasizing research on corrosion resistant coatings for the sulfur container and defining the failure mechanisms in the "Beta" alumina electrolyte tubes. Thermal and mechanical testing of cells for EV applications will be initiated, and the first laboratory version of an EV battery will be designed.

Zinc/Bromine ($0.5 million) - Laboratory efforts will be directed at increasing system efficiency from 70% to 75%. Design of modules for EV applications will be initiated; a plate stress study will be made to evaluate the effects of high power discharge, mechanical shock and vibrations.

Aluminum-Air ($0.2 million) - Development will continue on air electrodes for improved performance in full-scale hardware. Also, an improved crystallize will be fabricated, and the feasibility of recycling battery reactants will be evaluated.

9. Q. Your written statement mentions, "DOE now supplies electrochemistry development work specifically directed toward improving the energy efficiency of industrial processes." What does that mean?

A. The industrial sector of our economy accounts for about 30% of the Nation's total energy consumption (23.7 quads out of a total of 78 quads in 1980). Over 35% of this (5.5 quads) is used by the aluminum and chlor-alkali industries along. Even a small increase in the efficiency of the electrochemical processes used in these 2 industries would result in a significant decrease in the Nation's energy consumption.

Research sponsored by the DOE has identified major causes of inefficiency in the Hall-Heroult cells used for producing aluminum metal, and programs designed to overcome them have been initiated. These include the development of dimensionally stable titanium boride cathodes, development of nonconsumable anodes, and reduction of oxidation within the cells by reducing bubble formation and electromagnetic stirring forces. Efforts have also been initiated to develop alternative, less energy-intensive refining processes.

The chlor-alkali industry produces chlorine and caustic soda (sodium hydroxide) in electrolytic cells. A significant reduction in the voltage of these cells, and a corresponding increase in efficiency, can be achieved by replacing the hydrogen-generating cathode with one which consumes atmospheric oxygen. Such a cathode was developed with DOE support and is presently being evaluated to confirm its technical and economic merit.

The development of improved membranes, such as Nafion, would also result in increased efficiency in the chlor-alkali process and other industrial electrolytic cells. The development of multi-component transport theory, and transport data required for these membranes is currently under way. The synthesis of new ion-exchange membranes for industrial applications is also being investigated.

The manufacture of many organic chemicals requires energy-intensive processes that are often low in efficiency due to the numerous side reactions which occur. Improvements in the energy efficiency or process vield may be improved by the use of "paired synthesis" in flow through electrolysis cells, and such processes are being investigated.

10. Q. You also mention this work paralles development concurrently being supported by large sophisticated industries who are capable of increasing in-house R&D. Who are these sophisticated companies and precisely what are they doing that is the same as what DOE is doing?

A. The aluminum and chlor-alkaki industries are large, sophisticated industries. They are interested in improved efficiency, since the benefit is an immediate return on investment. For example, Alcoa has been cost-sharing with DOE the development of improved Hall cell technology for aluminum refining; and Diamond Shamrock is similarly cost-sharing the development of energy efficient chlor-alkali production technology. It is well known that other companies (e.g. Kaiser in aluminum and Allied Corporation in chlor-alkali) have significant in-house efforts and there is every reason to expect that much of this work will continue if government funds are cut off.

11. Q. In the budget you requested $7.22 million mostly for energy storage. Without generalizing and using terms like thermodynamics, kinetics, or generic research, in detail, exactly what is that request for, what is to be accomplished and by whom?

A. A major portion of the funds requested are for use in research and development related to improved and advanced batteries.

Lead-Acid Batteries ($1,500,000) - The main emphasis in this area is an improvement of lead-acid batteries for use in electric vehicles. The goals include development of lightweight, corrosion resistant plastics for battery components and increasing the life of electrodes. A specific goal is to demonstrate 600 charge-discharge cycles of battery life with a complete prototype battery having an energy density of 42-45 wh/kg. The work will be performed by Globe as a continuation of a present contract.

Nickel-Iron Batteries ($1,235,000) - This battery is also being developed with a view to ultimate use in electric vehicles. Increasing electrode life by use of alloys and fabrication techniques such as metallic wearing will again be one of the main efforts. It is planned to demonstrate 600 cycles life and an energy density of 50 wh/kg with a full pack of an iron-nickel oxide battery (Westinghouse/Eagle-Picher).

Zinc Bromine Battery ($500,000) - These funds will allow the completion of the first zinc-bromine storage module providing 20 kwh of energy and designed for solar energy storage applications. The energy density goal for FY 1983 for a zinc-bromine battery is 60 wh/kg (Exxon).

Sodium-Sulfur Battery ($1,500,000) - The sodium-sulfur battery is also being aimed at vehicular use with an energy density goal of 140 wh/kg for FY 1983 (Ford).

Aluminum-Air Battery ($200,000) - These funds will be used for testing individual modules (battery cells) which were developed in FY 1982 (Lawrence Livermore/Lockheed).

The remaining funds will be used for continuing the development of an alternating current (AC) propulsion system for electric vehicles ($1,700,000) under the field management of the Jet Propulsion Laboratory (industrial subcontractors not yet selected), and for battery testing and evaluation ($600,000) at the National Battery Test Laboratory under the direct management of Argonne National Laboratory.

12. Q. Summarize now and submit in detail for the record an account of all prior R&D investments made by DOE in Electric Energy Systems and Energy Storage for each and every project funded in FY 1981 but for which no funds have been requested in FY 1983. For each project, list the work accomplished to date, the amount of R&D yet to be completed in order to benefit the public, the estimated cost of the remaining R&D and the projected future economic impact should the work not be carried forward by industry or the utilities.

A. We offer the following list of Electric Energy Systems (EES) and Energy Storage (ES) project for the record (projected future economic impacts should work not be continued cannot be assessed). Since the pace of R&D depends on the occurence of breakthrough, which cannot be predicted, we can not estimate costs for remaining R&D with any accuracy.

Electric Energy Systems

1. Project: High Voltage Technology (ac and dc)

- Advanced Circuit Breaker, Surge Arrester and ancillary devices
- Higher Efficiency Materials/Equipment
- System assessments
- Electromagnetic Pulse (EMP) impact
- Superconducting generator

Progress: All prototype devices and higher efficiency material assessments will be completed with FY 1982 funds. Basic analysis of molecular structure of higher efficiency materials, EMP analysis, superconducting generator testing, and system assessments will be terminated.

2. Project: Underground Transmission

- Superconducting cables
- Ambient high capacity 1200kv cables
- Submarine cables

Progress: Brookhaven National Laboratories' superconducting cable has been fabricated and a 100-meter segment installed in its tested cryostat. Power tests will be completed in FY 1982, but impulse tests will not be initiated. Ambient prototype cables will be fabricated but not tested with funds committed through in FY 1982. Deep water submarine cable research has reached the point as well as repair splices and accurate means of locating and retrieving faulted sections.

3. Project: Electric Field Effects

- Small animals
- Cell/tissue
- Risk assessment for human hazard

Progress: Some effects have been found, but remaining research is aimed at finding whether these effects pose any hazard to humans. Finally, the risk assessment will look at all research to date, determine any gaps and evaluate hazard levels. This will be initiated in FY 1982 to determine how such a risk assessment should be conducted.

4. Project: Storage Applications (Electric Utility Load Leveling)

- Battery Energy Storage Test (BEST) Laboratory
- Advanced Battery Technology Testing and Evaluation
- Compressed Air and Underground Pumped Hydro Storage Technology Assessment

Progress: All compressed air and underground pumped hydro storage evaluation projects will be completed during FY 1982 with FY 1982 and prior year funds. DOE participation (currently on 50/50 basis with EPRI) in the BEST facility will be phased out and responsibility for continued operation and testing of advanced batteries at the facility will be transferred to EPRI and/or the utilities; sufficient funds have been committed through FY 1982 to complete the base line facility, to prepare the second bay for testing of small (500 kwhr) advanced prototype batteries, and to operate the facility for up to 2 years. One 500 kwhr advanced battery (a string of 10 prototype zinc-chloride modules) will be tested at BEST during FY 1983 with prior year funds. Plans to test and evaluate competing advanced battery prototypes (sodium-sulfur, zinc-bromine, etc.) at the BEST laboratory have been terminated.

5. Project: System Coordination and Control

- Emergency Detection and Control
- Operation of Multi-terminal High Voltage Direct Current (MTDC) Systems
- System Dynamic Performance
- Control of Very Large Scale Systems

Progress: In Emergency Detection and Control, fundamental progress has been made in estimating the likelihood of system failures, in developing control strategies for abnormal system-operating states and in developing concepts for decision aids for assisting operators to rapidly restart the system after major blackouts. In MTDC systems, advanced concepts have been developed for designing power flow modulation controls. In Systems Dynamic Performance, basic advances in sensitivity theory for linear multi-variable control systems have been made as well as new results on the stability of large power systems. In the Control of Very Large Scale Systems, the development, testing and evaluation of an advanced automatic generation control algorithm on the Wisconsin Electric Power Systems is complete. New theoretical results in decentralized control theory were also achieved.

6. Project: Communication and Operation Technologies

- Energy management for distributed systems
- Protection and safety needs of distributed systems
- Harmonic impacts
- Power conversion concept
- Renewable energy source analysis

Progress: The accomplishments include an analysis of tests of the capabilities of heat and/or cold storage technologies to assist in the control of power systems peak electrical demands, completed field test of load management systems for residential customers, the development of mathematical models to study the interaction between wind turbines and conventional power systems, development of a family of advanced power conditioners for AC/DC and DC/AC conversion, development of advanced concepts for the protection of distributed systems containing energy storage and production equipment, the development of analysis tools to determine the benefits of novel distributed-systems designs, the completion of the first phase of the initial phase of research on data coding methods, electrical noise analysis and data transmission technologies required for communication in distributed electrical power systems.

Energy Storage

7. Project: Non-Aqueous Batteries

Progress: The sodium-sulfur molten salt battery system, lithium-iron sulfide battery system, and room-temperature lithium systems are still in the feasibility determination stage. Energy densities of more than double that of advanced lead-acid have been demonstrated in the laboratory, but major improvements remain to be made in cycle life.

8. Project: Metal-Air Battery Development

Progress: Present work on the iron-air battery focuses on problems with electrodes, separators, and the need for an oxygen-evolution catalyst.

9. Project: Supporting Research

Progress: This project covers basic and applied research in a broad area of electrochemistry and applied research into materials for electrochemical systems. Areas of inquiry include research on corrosion-resistant seals, insulators and supports. Studies include thermodynamics, kinetics, electrocatalysts, and morphology of battery electrodes; investigation of battery performance phenomena; and improvement in battery design and scale-up criteria. Some activities have led to improvements in lead-acid batteries now on the market.

10. Project: Electrochemical Processes

Progress: This level-of-effort research covers electrolysis membranes, electro-organic synthesis, air electrode development and fuel cells for transporation, with possible applications in industrial processes.

11. Project: Stationary Applications

Progress: Activities covered in this project include the Hawaii Natural Energy Institute Battery Storage Assessment, Evaluation of Customer-Side-of-the-Meter Battery Storage, the Wind Energy Storage Assessment, the Small Commercial Photovoltaics Storage Assessment, the New York State Energy Research and Development Authority Load Management/Storage Application, and Battery Modeling Studies. These activities have produced reports and other information useful to the private sector as battery storage options are considered.

12. Project: Battery and Systems Testing

Progress: A large part of this has been for construction of the National Battery Test Laboratory. The standardized tests and impartial data collection and analysis available only at this facility will enable battery manufacturers to demonstrate the true merit of their batteries for EV use. Testing to date has been on advanced lead-acid and nickel-iron batteries.

13. Project: Aqueous Non-Flow Battery Systems

Progress: Specific energy of 68 watthours per kilogram has been demonstrated with a cycle life of 179 cycles for nickel-zinc batteries. Corresponding specific energies for the other systems are 48 watthours per kilogram for nickel-iron and 42 watthours per kilogram for lead-acid. General Motors has invested heavily in proprietary nickel-zinc battery research.

14. Project: Aqueous Flow-Battery Systems

Progress: Development of the iron-chromium system has reached the point where a marginally operative laboratory scale model exists. It faces remaining problems in membrane design, electrode performance, and the enhancement of the preferred chromium species.

15. Project: Thermal Storage

Progress: Work on carbonate salts for mid- and high-temperature applications; phase-change media behavior with construction materials, and development of thermal storage for use in residences have yielded results which indicate potential for saving large amounts of oil. Research on direct-contact heat exchange for solar applications and thermal storage and transport by reversible chemical reaction shows long-term promise to increase heat transport efficiency. There is still a need to improve properties of phase-change materials, improve system designs for direct-contact heat transfer, and optimize their action scheme for thermal storage and transport.

16. Project: Chemical/Hydrogen Storage

Progress: Prototype electrolysis systems have been tested including a solid-polymer electrolyzer, advanced alkaline electrolyzer and a static feed system with the potential to electrolyze brackish water. Associated research on materials, recovery of hydrogen from industrial waste streams, thermochemical methods for water splitting, and development of chemical heat pumps to upgrade waste heat also show promise of energy savings. Continued research to improve catalysis, electrolytes, membranes, and current collectors is needed to increase efficiency of electrolysis systems. Better materials and improved system design are needed for improving hydrogen recovery from waste streams and performance of chemical heat pumps.

17. Project: Mechanical Storage

Progress: Research to develop improved composite materials and rotor designs have resulted in flywheels with an energy density of 45 wh/kg. A flywheel is being fabricated for incorporation into an experimental electric bus in cooperation with DOT. Continued research is needed on long-term cycling effects on these materials and to investigate fatigue and creep properties unique to vehicular flywheels.

18. Project: Underground Storage

Progress: For seasonal thermal storage, aquifer injection testing has been completed in the 120 degree Fahrenheit - 195 degree Fahrenheit range. Computer modeling to predict heat and fluid flow in aquifers is completed and in good agreement with experimental results. For compressed air energy storage, reservoir stability criteria have been completed for salt domes and hard rock. An experimental test facility to confirm stability in aquifers is being designed and constructed. Further research is needed to evaluate high-temperature characteristics of aquifers to minimize geochemical and geological problems for seasonal storage. System designs for advanced compressed air energy storage systems need to be improved in order to eliminate the need for oil firing.

19. Project: Magentic Storage

Progress: Component development and automated control systems are completed for a 10 kwh system. The equipment, after verification testing is complete, will be shipped this summer to Tacoma, Washington, for installation on the BPA Pacific alternating current transmission line. Some feasibility studies have also been completed for large-scale magnetic storage, but all present work is funded by the Electric Power Research Institute.

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13. Q. You have obviously assessed the future benefits to the American public of continuing federal involvement in Electric Energy Systems and found there were none. Describe now and present in detail for the record your complete cost/benefit analysis on this program which led to this conclusion.

A. Benefit assessment studies of the Electric Energy Systems research program have been carried out in the past for the purpose of establishing relative priorities of proposed research activities. Even the most recent studies are out of date because assumptions regarding such basic parameters as cost of primary fuels, interest rates, inflation rates and expected penetration of advanced technologies are being impacted significantly by the President's economic recovery program. Careful review of such past studies in light of changed assumptions, however, indicates that continuing Federal involvement is unnecessary.

14. Q. How much oil could be saved per year if advanced storage batteries can be developed and electric vehicles were competitive in the market?

A. The potential petroleum savings that could be obtained from the introduction of electric vehicles with advanced batteries depends upon a number of factors: the relative price of and availability of gasoline and household electricity, the relative initial and operating costs for electric and conventional vehicles, the driving range capability of electric vehicles, and other factors related to consumer preferences in vehicles. The issue is further complicated by the fact that electric light duty trucks might have penetration rates higher than those for electric passenger automobiles. Furthermore, hybrid-electric vehicles might prove to be successful competitors to both all-electric and petroleum-powered vehicles.

With all the uncertainty surrounding the above factors, it is difficult to be more than suggestive in estimating potential petroleum savings. It is estimated that autos and light trucks will be consuming about 4 million barrels per day in the year 2000 (as compared with about 6 million barrels per day at the present). It is plausible that "competitive" electric vehicles could save 20% to 50% of the year 2000 estimate. This would amount to .8 to 2.0 million barrels per day of petroleum use.

15. Q. In FY 1980, the Federal Government invested $37 million in Electric Energy Systems and EPRI invested about $30 million. Do you have any idea how much industry invested?

A. Investment by the industry in research and development in those areas directly related to the Electric Energy Systems program comes from two sources: electric utilities and electric equipment maufactureres. In addition to the support of EPRI ($30 million), it is estimated that the electric utilities invested around $5 million in 1980. In testimony before this Subcommittee on December 8, 1981, Mr. A. L. Bethel of the Westinghouse Electric Corporation stated (page 4 of the prepared statement) that the electrical equipment manufactureres funded $100 million on electric transmission and distribution research in 1980. Mr. Bethel further stated that, in contrast to DOE funded R&D, which... "has been relatively long-term (5-15 years) and of greater uncertainty as to success,"

> "The utility or EPRI-funded interests are relatively near-term (1-5 years) with emphasis on technology that can be commercialized in that time period and have a direct benefit to the utilities.
>
> The electrical equipment industry ... must necessarily concentrate on that R&D which can be quickly brought to the market, and to a limited extent will participate with EPRI and DOE on those projects where it can be warranted."

16. Q. Have you completed a national investigation and analysis which identifies what company is going to work on what projects? That is, how all these individual "self-interest" efforts will form one complete national program? If so, can we have a copy of that analysis?

ELECTRIC ENERGY SYSTEMS

A. We have not carried out such an investigation and analysis. There are approximately 3,120 independent utilities of which 271 are investor-owned, supplying about 80% of the Nation's electricity, and the remainder are publicly-owned (Federal, State, municipal and co-operative) utilities. The utilities are authorized to operate as locally regulated monopolies within specified areas and their operations and financial performances are constrained by the interests of their service areas. The interests of the electric utilities geographically cover the entire country; hence, it may be possible that the aggregate of locally constrained interests will form a program which addresses the national research needs of the U.S. As I stated in my testimony before this subcommittee on March 25, 1982:

> The greater Federal presence advocated by previous administrations is not a desirable goal. It is our belief that utilities, EPRI, utility equipment manufacturers, and universities will build, over time, on the work formerly sponsored by EES. The cost-sharing contracts that we have had with industry will have been seed money. EPRI and the private sector will now have to choose what work to continue.

ENERGY STORAGE SYSTEMS

No national investigation and analysis has been made to identify what companies will work on what projects. The national effort is expected to evolve naturally, driven by the requirements of the marketplace. The following list, however, indicates where the private sector has, to date, shown interest in participating in certain project areas.

1. Under DOE sponsorship, the air cathode has been developed for industrial application in the electrochemical area. Diamond Shamrock has worked with Case Western Reserve in fabricating improved cathodes for chlor-alkali cells to produce chlorine. The improvements have resulted in projected gross energy savings of about 25% or 600 kwh per ton of chlorine. Diamond Shamrock has decided to continue this project with company funding because of these promising results, while acknowledging that "there is still much work to be done before thee first chlor-alkali plant will be built utilizing air cathodes."
2. The development of the hydrogen anode for zinc "winning" (electrolytic refining) taken over by New Jersey Zinc (now part of Exxon).

3. The initial development of sodium chloraluminate sulfur (+4) system has shown siginficant technical promise in terms of high voltage output per cell and high energy density. Although the system requires significant further R&D, the potential use is already evident in space vehicle applications where cost is not the primary consideration. The Bell Laboratories has, therefore, continued the work independent of Government funding.
4. Induced magnetic field modeling work on Hall cells, currently at Reynolds Aluminum shows 4% improvement currently, with potential for 30%.
5. Parisian Department Stores (Alabama) installed (with their own funds) a seasonal storage system for storing winter chill in an aquifer for use during the summer. DOE plans to monitor system performance and to use the data for aquifer modeling.
6. EPRI is negotiating with DOE to operate the DOE Compressed Air Energy Storage field equipment at Pittsfield, Illinois in FY 1983.
7. Corning Glass wants DOE-developed composite flywheel technology for development of commercial flywheels.
8. Beckman Instrument Company will use DOE composite flywheel technology to compete with German invasion of their centrifuge market.

9. Carrier Corporation has recently completed a DOE-funded study of ice storage for air conditioning. The study included a survey of ice-making and storage technologies, well as a review of related technical problems concerning such topics as heat transfer, materials, and performance characteristics. The next phase of this activity will involve hardware development. Carrier is reported to pref to undertake this new phase on their own.

17. Q. Present the details on the privately-funded research being performed at Sandia Laboratory that you mentioned during the hearing--that is, what are they doing, what is to be accomplished, how much are they investing per year, and how do they reimburse the Government for use of the facilities?

A. I was mistaken in my understanding of the work being done at Sandia. The work there is Federally-funded, although industry has donated the molten salts being tested there in the thermal storage area.

18. Q. How can you justify termination of the REDOX program at this time in light of the $6 million investment to date? Several companies have shown interest in cost sharing. What is the status of development and what research remains to be completed?

A. The NASA Redox battery development has significant problems many of which seem unlikely to be solved even with large amounts of additional funding. Some of these problems areas are:

1. The system voltage is low and varies markedly with the state of charge. This would require power conditioning equipment having a wide voltage acceptance range and would increase the power conditioning cost substantially.
2. The system requires a membrane for solution separation. While significant progress has been made in membrane development over the years, a membrane with the required performance has yet to be identified.
3. The normal operating voltage for the chromium electrode during charge is more negative than the hydrogen evolution voltage. Thus, much of the charging current is normally lost in hydrogen generation. A gold-lead catalyst has been developed to reduce this problem; but in addition to the high cost of gold, the long-term stability of the catalyst has yet to be demonstrated.

4. The solution involved in this battery utilizes chromium in two forms, "hexa" and "penta". On charging, the "penta" is converted to the "hexa" form and this impedes the charging process and increases the power losses. An effective method of converting the "hexa" to "penta" is required. To date no effective method of achieving this conversion exists.
5. The question about chromium cost is one of the most controversial aspects of this Redox system development. At the existing market price of chromium chloride, the basic ingredient for the chromium electrode, most reviewers believe the system to be too expensive, even if the technical goals could be achieved.

19. Q. In your area of responsibility, Electric Energy Systems, what private companies are working in R&D to developed advanced equipment for 1) Reactive Power Compensation, 2) Line Protective Systems, 3) Power Control and Communication Systems, 4) HVDC Transmission Interface Equipment, 5) 1200 kv Gas Insulated Systems, and 6) Underground Gas Insulated Transmission.

A. With respect to the electric energy systems program, we carefully reviewed every proposed project, and we decided either that they were no longer appropriate for Federal support or they were not of a high enough priority to borrow money for.

We have the following information in private sector R&D on advanced equipment:

1. Reactive Power Compensation -- R&D by ASEA (Sweden) and BBC (Swiss), and under DOE/EES contracts GE and Westinghouse (US).
2. Line Protective Systems -- DOE investigative research with GE, McGraw Edison, and Systems Control to determine future needs for future automated distribution systems.
3. Power Control and Communication Systems -- the only R&D being done now is product improvement by numerous US and European companies. Advanced concepts are not being developed.

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4. HVDC Transmission Interface Equipment -- ASEA (Sweden), BBC (Swiss) and GE (US); at this time it is almost entirely product improvement, not R&D.
5. 1200 kv Gas Insulated Systems -- BBC (Swiss), ENEL (Italy), ASEA (Sweden), Siemans (West Germany), and under DOE/EES contracts BBC/USA, GE and Westinghouse (US).
6. Underground Gas Insulated Transmission -- Westinghouse (US) under DOE/EES contract and Alcoa/GE under DOE/EES contract.

20. Q. What is the status of development in these areas?

A. The following information is the status, as best we know it, of the projects in these areas:

1. Reactive Power Compensation -- Investigative phases are complete on reactive power compensator by Westinghouse and GE.
2. Line Protective Systems -- Investigative/assessment phase of work is about 80% complete on all DOE contracts.
3. Power Control and Communications Systems -- No advanced communication and control research is underway. Some assessment of future system needs are nearing completion.
4. HVDC Transmission Interface Equipment -- No advanced concept research is under contract.
5. 1200 kv Gas Insulated Systems -- Laboratory model devices in the U.S. have been completed and tested. Full scale prototype circuit breakers and transformers will not be funded.
6. Underground Gas Insulated Transmission -- Prototype U.S. devices are vitually complete but not tested. Advanced materials are required for further improvements.

21. Q. What research needs to be done on the biologica effects of electric field currents? Who will do this if the government does not?

A. Work is nearing completion on the effects on small animals. EPRI has completed the first phase on their swine study. Required yet is to resolve inconsistencies found between species, to complete work on cells and tissues, and to initiate an extensive risk assessment to relate all research to human hazard (if any). EPRI is heavily involved and will continue their participation.

22. Q. What percentage of the cost of bringing a new product to market would you say is R&D? What percentage would be non - R&D and what might be the elements of these costs?

A. On the average, R&D expenditures make up about 2-3 percent of cost. This ratio has been as high as 4-5 percent in the early sixties, but has been declining gradually since then. There exists a large variation in this figure across industries, however. The other elements of cost are materials, labor, fuel, transportation, variable overhead, such as supplies, etc., and fixed costs, such as plant and equipment.

23. Q. Do you think industry will perform basic short-term research or long-term research or both? Why?

A. It is anticipated that the private sector will pursue technology development efforts at rates consistent with their economic potential.

24. Q. What is a realistic pre-tax interest coverage ratio for utility companies to maintain high bond ratings?

A. It is impossible to set one interest coverage ratio for all utility companies. The realistic pre-tax interest coverage ratio depends upon the specific conditions surrounding a particular utility.

25. Q. In your opinion, how can industry justify long-term, high risk R&D to its shareholders?

A. The Federal percentage of total R&D investment varies among industries but is a relatively small percentage in many. Long-term, high-risk R&D can be justified on the basis of its potential for providing a return on investment over the long run and for ensuring continuation of improvements in efficiency beyond the short-term.

26. Q. The North American Electric Reliability Council (NERC) reported in their 11th Annual Review that utility companies are not in a position to make financial investments. What is your basis then for terminating Electric Energy Systems work? Is it that you believe that technology has reached its zenith? What are the stakes for future U.S. markets overseas? Would you compare our prospects with those of the Japanese given our historical adversary relationship between business and the Federal government. Doesn't precipitous withdrawal from these R&D programs merely reduce the chances for an effective government/industry partnership?

A. Although the private sector (including the Electric Power Research Institute, Gas Research Institute, Edison Electric Institute and utility industry suppliers) is expected to pick up many activities, it should be pointed out that the reduction in budget levels was not contingent upon such action by the private sector. Some of the activities which will not be Federally supported lack sufficient promise to warrant continued investigation. Therefore, the budget decisions have been based upon considerations that may override the simple question of utility company support for such activities.

Related to this is the Administration's view that past economic policies which have contributed to the inordinate expansion of the Federal budget, growth of the deficit, high inflation and high interest rates have created a competitive disadvantage for U.S. industry with respect to foreign competition. The primary thrust of this Administration's program is to reduce the growth in Federal spending in order to bring down inflation and interest rates and contribute to economic recovery. Economic recovery is the essential ingredient necessary to restoring American industry to its rightful place of leadership in the world economy.

27. Q. Considering the position of Public Utility Commissions (PUCs), how can utility companies finance long-term research?

A. It is anticipated that, in addition to utility companies, the Electric Power Research Institute (EPRI), the Gas Research Institute (GRI) and utility industry suppliers will assume greater responsibility for the technical development, demonstration and commercialization of advanced technologies which have the greatest potential to survive in the marketplace.

28. Q. In making decisions about investments, how would you expect industry to weigh increased plant capacity and automation against R&D?

A. We would expect industry to develop and implement a balanced program of capital investment and R&D, to ensure both short-term and long-term improvement in productivity.

29. Q. Regarding tax incentives, since 1954, firms have been given the option of fully deducting R&D expenditures in the year in which they occur. What are the differences in the new tax law which will encourage greater R&D commitments by private industry?

A. Under the old provisions of the tax law, a tax payer could expense R&D costs incurred in connection with trade or business or could elect to amortize them over a period of at least 60 months. Under the new tax law, an additional 25% investment tax credit is allowed for incremental expenditures (over a 3 year base) for:

-- in-house research wages and supplies, plus cetain lease or other charges for research use of computers, laboratory equipment, etc.

-- 65% of contract research.

-- 65% of corporate basic research grants.

Fifty percent of the research expenditures of new tax payers are treated as incremental. Credit is limited to tax liability reduced by certain other credits, including investment and energy tax credits.

Energy costs have increased since many in-place products and processes were developed. In this context, R&D

is likely to result in improved energy efficiency. The incremental R&D resulting from this subtitle will likely have a significant indirect conservation benefit. Overall we expect:

Increased R&D in conventional energy technologies.

Increased R&D in energy conservation technologies.

Increased R&D is apt to result in a broad range of processes and products with higher efficiency than those they replace.

Companies, including new ventures, developing new renewable technologies can benefit from the tax credits even if they are not very profitable companies. Research-intensive industries (such as the solar industry) will benefit relatively more tha non-research-intensive industries (such as steel or cement).

30. Q. What are the 3 or 4 most promising engineering projects that you have been funding in this program? Will these be developed and field-tested if the government program is abandoned? What assurances, if any, do you have that they will be continued?

A. We have been funding 4 engineering projects that we considered to be the most promising. They are:

1. Gas Insulated Transformer. The first phase of the project, dealing with concept development and technology base research, indicates that genuine breakthroughs are feasible in designing a next-generation power transformer with substantial reductions in weight, size, losses and noise. Based on this initial success, private sector contributions toward the first phase have increased from $1.3 million out of $8.9 million in the most recent plan. It is expected that the next phase, prototype development and testing, will be funded entirely by the private sector.
2. Advanced Power Systems Operation Technology. The theoretical base and preliminary application concepts have been established for advanced techniques in Optimum Operation Scheduling of power system generating resources and in Emergency Detection and Control of large interconnected power systems. The analytical techniques, developed primarily through contracts with

universities and high-technology aerospace firms, are expected to have a significant impact on future utility operations, reliability and improved efficiency. This will enable utilities to deal more effectively with major operating emergencies. One utility has already field-tested an advanced automatic generation control algorithm based on this work; EPRI has expressed interest in adapting the techniques developed in these projects to practical on-line operating tools.

3. Battery Energy Storage Test (BEST Laboratory. A national test facility has been established which will permit testing of advanced storage batteries (for electric utility load leveling applications) in a utility operating environment. The BEST laboratory will provide the essential information required by battery deverlopers and the utilities for decisions on the technical and economic feasibility of advanced battery energy-storage prototypes. Sufficient funds have been committed through FY 1982 to complete the baseline facility, equip the first advanced test bay and operate the facility for up to 2 years. It is expected that EPRI and/or the utilities will be able to fund the continued operation of the facility when DOE terminates its participation as a co-sponsor (50/50 basis) with EPRI.

4. Electric Field Effects. This is an extensive program designed to investigate the effects of 60 Hz electric fields from high voltage (ac and dc) power transmission lines on plants and animals, and to assess whether the expected operation of present and future high voltage lines pose any significant risk to humans. Effects have been replicated in various animals. Remaining research will be devoted to determining whether these effects pose any hazards to living organisms. We are encouraging the private sector to increase their participation in this activity and to incorporate an appropriate mechanism so that a perception of unbiased objectivity is achieved.

31. Q. Please describe the impact of minimum streamflow requirements recommended by the U.S. Fish and Wildfire Service on Small-Scale Hydro projects. What research has DOE been funding in this area and why?

A. The impact of minimum streamflow requirements on small-scale hydro projects can be significant and may include: a reduction in total energy which can be produced, since water released to meet minimum flows is not necessarily available for power production; a reduction in the value of electricity produced, due to restrictions on the timing of the generation; and an increase in captial costs to provide greater flexibility for the combined generation and minimum flow operations. Another result has been the uncertainty for potential developers as to the exact requirements which will be imposed for specific projects, resulting from the general lack of recognized guidance for determining such requirements. In FY 1981, DOE initiated paper research to help provide a scientific basis for evaluating flow requirements for aquatic biota below hydroelectric dams, particularly for Eastern streams. This was initiated in cooperation with the Federal Energy Regulatory Commission (FERC), the Fish and Wildfire Service (FWS), and other interested agencies. By the end of 1982, we plan to conclude field testing of comparative methodologies on selected basis for FWS recommendations and FERC licensing decisions, as well as guidance for potential developers.

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